MACHINERY

THE DESIGN OF AUTOMOBILE SPRINGS*

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IT is doubtful if scientific calculations ever entered into the design of the original forms of such springs as are used under ordinary road carriages. Satisfactory as they are, they are not engineering results, but accepted standards born long ago of the cut-and-try methods of the blacksmith shop. Their manufacture belongs to such arts as are taught by father to son, or acquired through years of experience, during which have been gathered the "tricks of the trade." The manufacturer of this class of springs does not attempt to arrive at results by mathematics. He has learned as a part of his trade that certain styles of carriages should have certain springs.

Sufficient time did not exist during the development of railroad cars for a gradual development of definite types of springs for various types of cars. It devolved, therefore, upon the engineer to design these springs; but as soon as the spring maker found that the 70,000, 80,000, and 100,000-pound capacity car each had its own peculiar set of springs, and that any car could be fitted with springs according to its capacity, he adopted the engineer's designs as another class of standards. Railroad cars, while resting on springs whose dimensions were originally scientifically estimated, are now, therefore, suspended largely upon springs belonging to a few fixed classes.

With the advent of the automobile, came a carriage traveling fast over uneven country roads, meeting severe usage in inexperienced hands, and demanding the extreme of comfort and safety. The question of springs and spring suspension thus becomes of primary importance, so that in these carriages each particular design requires a specially designed suspension. Automobile springs are fundamentally cantilevers, the same as all leaf springs. This class of springs more readily lends itself to an easy vibration, as well as to a better general design of the machine. It is possible to carry a load on a narrow-leafed elliptic leaf spring where there would not be room for a helical spring. Also, the addition of a leaf to an elliptic leaf spring adds to its capacity without changing its deflection, while the addition of a coil to a helical spring does not change its capacity but adds to its deflection.
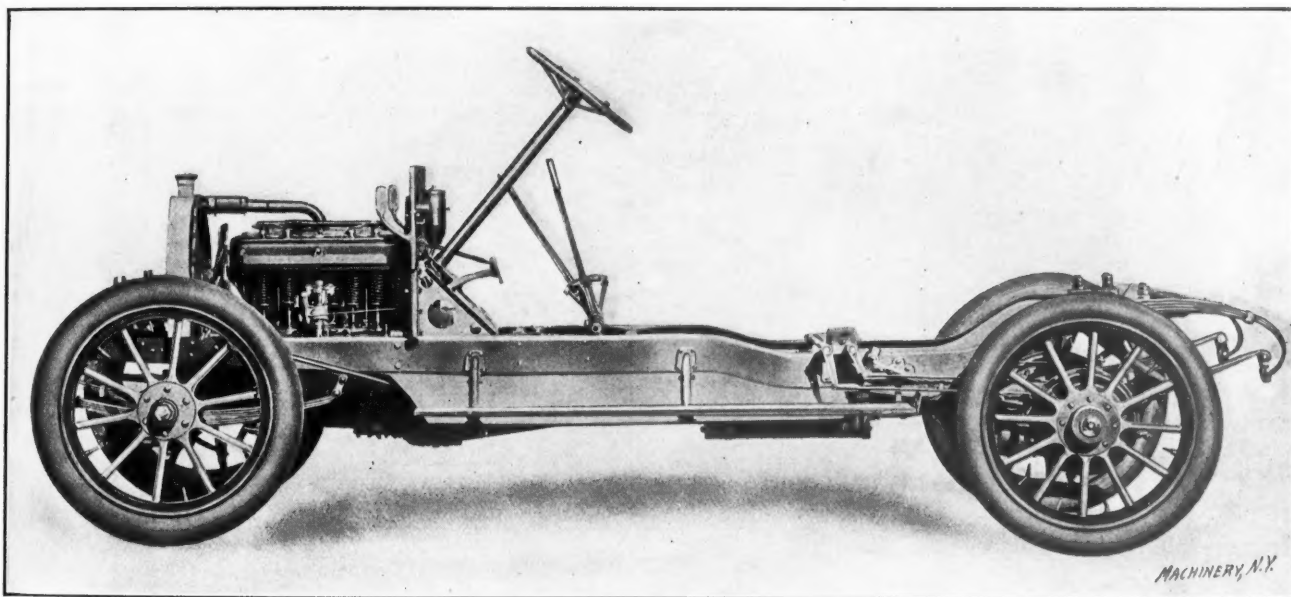

Fig. 1. Chassis of an F. B. Stearns Motor Car, showing Three-quarter Elliptic Spring Suspension in Rear and Semi-elliptic Springs in Front

Any leaf spring, tightly banded around the middle, should be considered as composed of two cantilevers of length l, where l is one-half the distance from center to center of the end bearings less one-half the width of the band. The length of each cantilever is then expressed (see Fig. 2):

$$l = \frac{c - w}{2}$$

To consider a spring a simple beam of length c, is to overlook the effect of the band. It is easily demonstrated that variations in the width of the band cause corresponding variations in the strength and deflection of the spring. The elliptic spring, graduated throughout, with but *one* leaf in each section extending from end bearing to end bearing, is fundamentally a cantilever of *uniform strength;* and the formulas applicable are based on the fundamental formulas of that type of cantilever. An elliptic spring with *all* leaves in each section extending from end bearing to end bearing, is, on the other hand, a cantilever *of uniform section*, and the formulas for this type of cantilever are then applicable.

The springs used in automobile practice are frequently combinations of these two forms, inasmuch as a considerable portion of the leaves extend the full length from bearing to bearing. It follows that neither of the above formulas will apply, but that the applicable formulas may be derived by combining the fundamental formulas for the two types of cantilevers. The load capacity of a cantilever is not affected by its form, for in either case:

$$P = \frac{S b h^2}{6 l}$$

in which $P =$ load,

     $S =$ allowable stress,
     $b =$ width of beam,
     $h =$ thickness of beam,
     $l =$ length of cantilever.

In other words, the load capacity is equal for like conditions, such as stress, size of beam, and length of span.
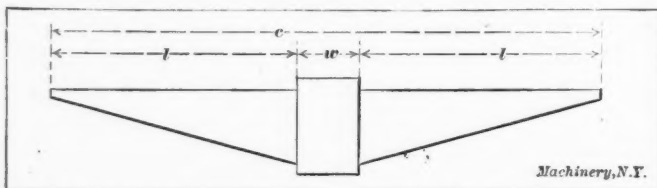

Fig. 2. Diagrammatical Sketch of Graduated Spring, giving Length Notation used in Formulas

A great difference exists, however, in the deflections under the same load, one being fifty per cent more than the other:

$$f = \frac{4 P l^3}{E b h^3}, \text{ for uniform section cantilevers,}$$

$$f = \frac{6 P l^3}{E b h^3}, \text{ for uniform strength cantilevers,}^*$$

in which $f =$ deflection, and $E =$ modulus of elasticity.

When such a difference as this exists, it is rather remarkable that many engineers calculate the properties of an elliptic spring no matter what the cantilever conditions, as though all elliptic springs were subject to the same rules and formulas; but, as a matter of fact, the proportion of back leaves, or the leaves on the longer side of the spring which commonly extends the full length, ranges from 5 to 50 per cent of the total number of leaves. It is not unusual to see attempts made through actual tests of the springs themselves to find the proper constant with which to modify the uniform strength equations so as to render them applicable to springs composed of uniform section cantilevers in combination with uniform strength cantilevers. The desired modifier, however, is a variable quantity, depending upon the relative size of the fundamental spring elements.

Lack of due consideration of this combination of different cantilevers accounts also for the different and conflicting formulas which various authorities advance. Thus Goodman, in "Mechanics Applied to Engineering"; Reuleaux, in his "Constructeur"; and "Des Ingenieurs Taschenbuch" (Hütte), give formulas all of which reduce to uniform strength cantilevers. Molesworth and the Automotor Pocket Book base their formulas on uniform section cantilevers. Henderson, who assumed all semi-elliptic springs to contain one-fourth full length leaves, and made an approximation of the result, was the first to recognize the influence of the combination of cantilevers.

Deduction of General Formulas

For further consideration we will adopt the following notation, discussing only the semi-elliptic spring:

$P =$ total load on spring,.
$P_1 =$ portion of load on one end of spring,
$P' =$ portion of load on one end of full-length leaves, or on uniform section cantilever,
$P'' =$ portion of load on one end of graduated leaves, or on uniform strength cantilever,
$n =$ total number of leaves,
$n' =$ number of full-length leaves,
$n'' =$ number of graduated leaves,

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* The formula given is that for a cantilever of uniform strength where the height h is uniform, but the width of the section of the cantilever decreases towards the outer end; b is the width at the support.—EDITOR.

$$r = \frac{n'}{n},$$

$S =$ maximum fiber stress in spring,
$S' =$ maximum fiber stress in full-length leaves,
$S'' =$ maximum fiber stress in graduated leaves,
$f =$ total deflection of banded leaves,
$f' =$ total deflection of full-length leaves if unbanded,
$f'' =$ total deflection of graduated leaves if unbanded,
$b =$ width of leaves,
$h =$ thickness of leaves,
$l =$ length of cantilever,
$L =$ net length of spring, i. e., actual distance between end bearings, less width of band,
$x =$ proper initial space between fundamental cantilevers before banding.

It is but reasonable to assume that the maximum fiber strain should be the same in both fundamental parts, or

     $S' = S''.$

But

$$S' = \frac{6 P' l}{n' b h^2},$$

$$S'' = \frac{6 P'' l}{n'' b h^2}.$$

Hence $\dfrac{P'}{P''} = \dfrac{n'}{n''}.$

In a well-designed spring there should be, at full load, a division of the work proportional to the respective number of leaves in the two fundamental parts. The fundamental formulas of the two cantilevers have shown, however, that such proportional loads would produce different deflections in their respective carriers. This difference in deflection would cause a separation of the two portions of the spring were they initially together and unbanded. Were they initially together and banded the result would be internal stress under load which would mean that a division of the load proportional to the respective number of leaves in the two fundamental parts could not exist.

It is evident that by placing a space between the two fundamental parts when unloaded and unbanded, equal to the differ-
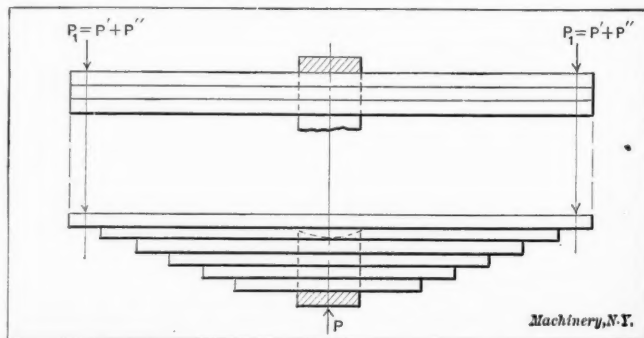
Fig. 3. Showing Division of Spring into Cantilevers of Uniform Section (Upper Portion) and Cantilevers of Uniform Strength (Lower Portion). One of the Full Length Leaves should always be considered as a Part of the Graduated Leaves

ence between the two deflections, there will result no space between the two fundamental parts at full load; and hence if banded in this position there will be no internal stress, so that the load on each part will be proportional to the number of leaves in that part. If then the load be removed, it follows that the band alone holds the two portions together and that there must exist a resulting stress upon the band and leaves.

Now

$$f' = \frac{4 P' l^3}{E n' b h^3} \tag{1}$$

and

$$f'' = \frac{6 P'' l^3}{E n'' b h^3} \tag{2}$$

But, as shown,

$$\frac{P'}{P''} = \frac{n'}{n''},$$

or

$$P' = \frac{n' \, P''}{n''}.$$

Hence $f' = \dfrac{4 \, P'' \, l^3}{E \, n'' \, b \, h^3}$, as derived by substituting in (1).

Hence,

$$f'' - f' = \frac{2 \, P'' \, l^3}{E \, n'' \, b \, h^3}.$$

Also, since

$$\frac{P'}{n'} = \frac{P''}{n''} = \frac{P_1}{n} = \frac{P}{2 \, n},$$

Fig. 4.   Front Spring Arrangement of the 1910 Model Winton Six-cylinder Car

we have

$$f'' - f' = \frac{P \, l^3}{E \, n \, b \, h^3}.$$
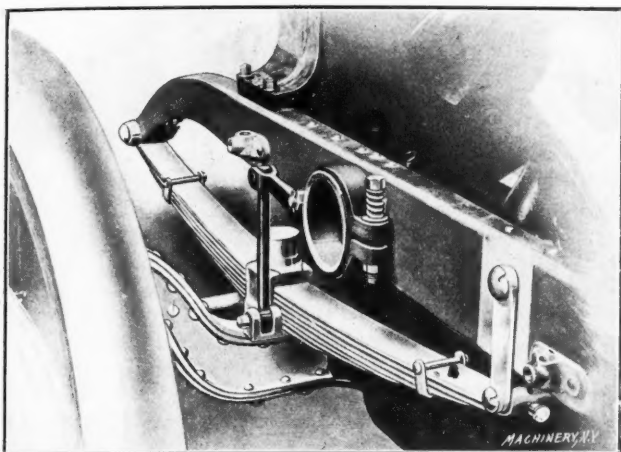
Also since

$$l = \frac{L}{2},$$

$$f'' - f' = \frac{P \, L^3}{8 \, E \, n \, b \, h^3},$$

or

$$x = \frac{P \, L^3}{8 \, E \, n \, b \, h^3}.$$

This last expression is then a general expression of the proper initial distance between the two fundamental portions
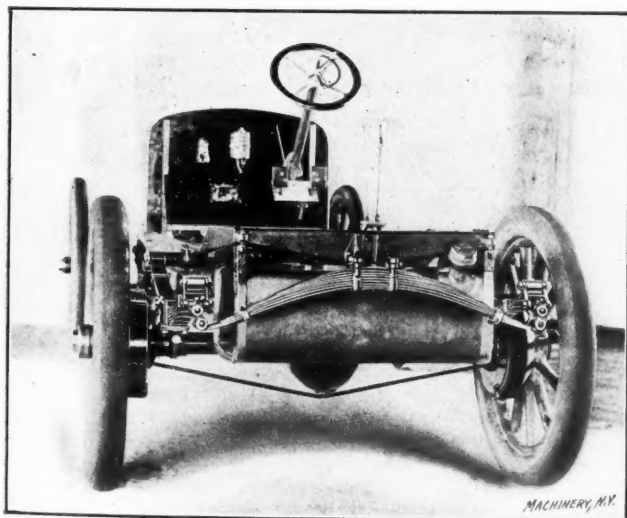

Fig. 5.   Spring Support of the Lozier Motor Co.'s "Light Six" Car

before banding, expressed in terms of total load on spring, total number of leaves in spring, and net span of spring. . To find the actual working deflection of the entire spring it is only necessary now to ascertain how much either portion is deflected by the process of banding. For this purpose let us adopt the following notation:

P_x = force exerted by band,

f_x' = deflection of full-length leaves caused by band,

f_x'' = deflection of graduated leaves caused by band.

Then,

$$f_x' = \frac{2 \, P_x \, l^3}{E \, n' \, b \, h^3} \quad \text{and} \quad f_x'' = \frac{3 \, P_x \, l^3}{E \, n'' \, b \, h^3}$$

Hence

$$\frac{P_x \, l_3}{E \, b \, h^3} = \frac{f_x' \, n'}{2} = \frac{f_x'' \, n''}{3}$$

or

$$f_x' = \frac{2}{3} \left[\frac{(1 - r)}{r} \right] f_x''$$

But

$$f_x' + f_x'' = \frac{P \, l^3}{E \, n \, b \, h^3}$$

Hence

$$f_x'' + \frac{2}{3} \left[\frac{1 - r}{r} \right] f_x'' = \frac{P \, l^3}{E \, n \, b \, h^3}$$

$$f_x'' = \left[\frac{3r}{2 + r} \right] \frac{P \, l^3}{E \, n \, b \, h^3}$$

But

$$f_x'' = \frac{3 \, P_x \, l^3}{E \, n'' \, b \, h^3}$$

Hence

$$\frac{3 \, P_x \, l^3}{E \, n'' \, b \, h^3} = \left[\frac{3 \, r}{2 + r} \right] \frac{P \, l^3}{E \, n \, b \, h^3}$$

or

$$\frac{3 \, P_x \, l^3}{E \, (1 - r) \, n \, b \, h^3} = \left[\frac{3 \, r}{2 + r} \right] \frac{P \, l^3}{E \, n \, b \, h^3}$$
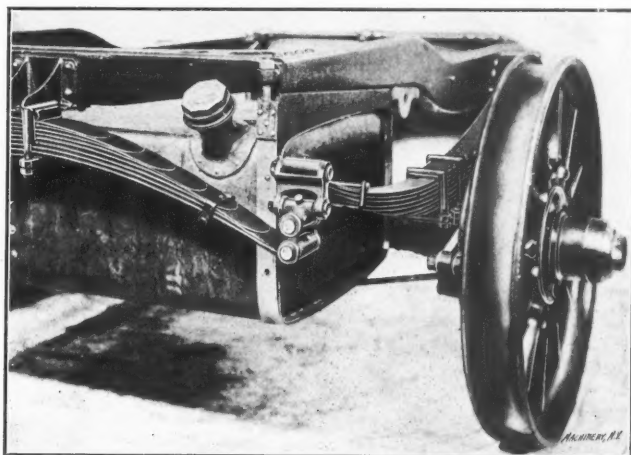
Fig. 6.   Arrangement of Semi-elliptic Springs on the Lozier Motor Co.'s Four-cylinder Model

or

$$P_x = \left[\frac{r \, (1 - r)}{2 + r} \right] P$$

The expression inside the bracket in the above equation becomes zero for either extreme value of r, as would be expected, the extreme values of r being unity and zero. The formula gives the force exerted by the band, $i.\ e.$, the load upon the band.

The total deflection of the graduated leaves, as already developed, is,

$$f'' = \frac{3 \, P \, l^3}{E \, n \, b \, h^3}.$$

The deflection of the graduated leaves, caused by the band, is

$$f_x'' = \left[\frac{3 \, r}{2 + r} \right] \frac{P \, l^3}{E \, n \, b \, h^3}$$

The difference is, therefore, the deflection left to the graduated leaves after banding, or the general formula sought for the deflection of such a spring:

$$f'' - f_x'' = \left\{ 3 - \left[\frac{3 \, r}{2 + r} \right] \right\} \frac{P \, l^3}{E \, n \, b \, h^3}$$

or,

$$f = \left[\frac{6}{2 + r} \right] \frac{P \, l^3}{E \, n \, b \, h^3}$$

or, since $l = \dfrac{L}{2}$

and

$$P = 2\,P_1 = 2 \left[\frac{S\,n\,b\,h^2}{6\,l} \right]$$

$$f = \left[\frac{6}{2+r} \right] \left[\frac{2\,S\,n\,b\,h^2}{3\,L} \right] \frac{L^3}{8\,E\,n\,b\,h^3}$$

Hence

$$f = \frac{1}{2\,(2+r)} \times \frac{S\,L^2}{E\,h}.$$

This last expression is then a general formula for the deflection of all semi-elliptic springs. If all the leaves are graduated, $r = 0$, and

$$f = 1/4 \times \frac{S\,L^2}{E\,h}.$$

If all the leaves are full length, $r = 1$, and

$$f = 1/6 \times \frac{S\,L^2}{E\,h}.$$

As was to be expected, the spring composed of all graduated leaves has a deflection, according to the above gen-
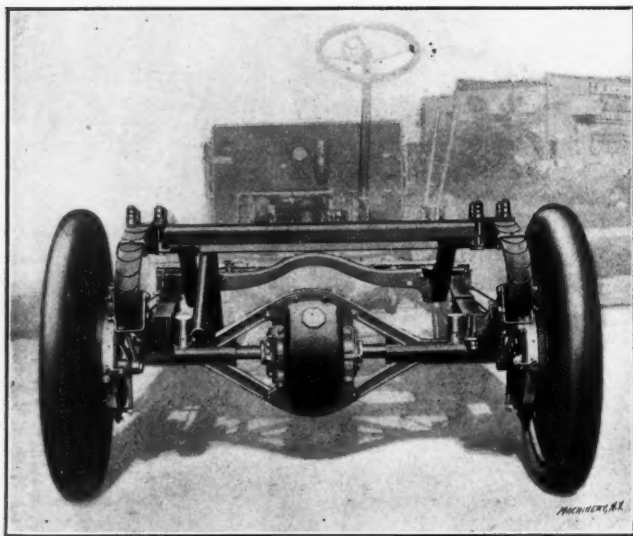

Fig. 7. Three-quarter Elliptic Spring Suspension on the F. B. Stearns Co.'s 15-30 H. P. Car

eral formula, 50 per cent above that of a spring composed of all full-length leaves. For values of r above zero, the deflection will be found to decrease until r equals unity.

General Remarks

The general formulas given above were first deduced by the writer in the early part of 1905, at which time they were placed before Prof. C. H. Benjamin, then of the Case School of Applied Science, with a view of making extended experiments for the preparation of a thesis. It was the intention to have springs built with initial space as deduced, and compare the actual deflections of such springs with the estimated deflections. Although these experiments were not carried out, they are mentioned because it is believed that when such experiments are made, they will prove valuable. The deduction of the formulas is here published for the first time. This deduction was made in connection with certain springs which were giving very poor service, although designed by the same formulas as other elliptic springs. It was the writer's conclusion that had the springs been built with the proper initial space between the fundamental parts, these springs would not have broken, and that the omission of this space caused an over-stress in the full-length leaves, and an under-stress in the graduated leaves, which caused the over-strained leaves to break, throwing an overload upon the previously under-stressed leaves which also broke when the stress was excessive. This conclusion seems to explain why springs of this type are frequently found with only the long leaves broken; the remaining leaves, all being of one type, divide the resultant overload evenly so that the over-stress is not so excessive. Perhaps the strongest indication of the correctness of the deduction lies in the well-known fact that the percentage of breakage is always much greater with semi-elliptic springs (of the combination type, usually) than with full elliptic

springs. Also, it is generally found upon unbanding these springs that no initial space exists.

Comparison of deflections estimated from the above formulas, with actual deflections has in some cases been quite satisfactory, while in other cases the actual deflections have appeared closer to those estimated by uniform strength formulas. In such cases where the writer has been able to make comparisons, however, the springs had been *made to specified deflections which evidently were estimated by the uniform strength formulas.* Experienced spring makers know that it is quite possible by putting a "pull" in the springs to vary the deflection and load. This trade term, "pull," is itself nothing more nor less than the introduction of an initial space between the leaves before banding.

Suspension of Automobiles

In road carriages, except in the heavier wagons, it is usual to find but two springs, one over each axle placed across the width of the carriage. In automobiles, one finds almost invariably at least the rear suspended upon two springs running lengthwise of the car, while, as is shown in the accompanying illustrations, it is the tendency to use the same suspension in the front. Such an arrangement takes up the forward and side lunges in a manner impossible with simple transverse springs. The further use of links and shackles, and of scroll ends, adds to the comfort, allowing the car to swing upon the springs rather than to be thrown upon them. In quite a few models, the two rear springs are attached in front to the frame and in the rear to a platform spring, which is itself attached to the center of the rear cross member of the frame. The three-quarter elliptic spring lends itself to both comfort and convenience of arrangement, and is rapidly coming into general use in this country, our manufacturers having apparently adopted it from foreign cars.

Steel Used in Automobile Springs

Automobile springs call for a high grade of steel, the ordinary spring steel lacking in strength and elasticity. Various grades of high carbon, silicon, manganese, nickel, chromium, and vanadium steels are used. Often such alloys are used as silico-manganese, chrome-nickel, and chrome-vanadium, the stiffening elements seeming to rank in the order given. Data as to the physical properties of such steels cannot well be given, as such properties must depend upon the proportions in the particular alloy used. Certain alloys of the vanadium group having an elastic limit of from 180,000 to 225,000 pounds per square inch, and tensile strength from 190,000 to 250,000 pounds, appear to be the most ideal steels yet produced.

Calculations of Springs

The calculation of spring properties by formulas is long and tedious. The writer appends, therefore, a table based on a modulus of elasticity of 25,400,000 and a fiber stress under

SEMI-ELLIPTIC SPRING TABLE

Giving safe load and deflection for 1 inch wide leaves, 1 inch net length. Used only when all leaves are fully graduated

Thickness of Leaf	P_u	f_u	Steel	P_u	f_u
$\frac{1}{32}$	52.08	0.02519	$\frac{9}{32}$	4218.75	0.00280
$\frac{1}{16}$	208.33	0.01260	$\frac{5}{16}$	5208.33	0.00252
$\frac{3}{32}$	468.75	0.00840	$\frac{11}{32}$	6302.08	0.00229
$\frac{1}{8}$	833.33	0.00630	$\frac{3}{8}$	7500.00	0.00210
$\frac{5}{32}$	1302.08	0.00504	$\frac{13}{32}$	8802.08	0.00194
$\frac{3}{16}$	1875.00	0.00420	$\frac{7}{16}$	10208.33	0.00180
$\frac{7}{32}$	2552.08	0.00360	$\frac{15}{32}$	11718.75	0.00168
$\frac{1}{4}$	3333.33	0.00315	$\frac{1}{2}$	13333.33	0.00157

maximum safe load of 80,000 pounds per square inch. Calculations of springs made of materials having other physical properties are made by simple proportion. This table is to be used only when all leaves are fully graduated.

The safe load on one leaf one inch wide is found by dividing the constant given under P_u by the net length. The corresponding deflection is found by multiplying the constant given under f_u by the square of the net length.

Example: What is the safe load on a semi-elliptic full graduated spring of five leaves if of one-quarter by two inch steel; length between end bearings, thirty-six inches; band or seat, three inches?

Net length $= 36 - 3 = 33$ inches.

Load on one leaf one inch wide $= \dfrac{3333.33}{33} = 101.01$ pounds.

Load on one leaf two inches wide $= 2 \times 101.01 = 202.02$ pounds.

Load on five two-inch leaves $= 5 \times 202.02 = 1010.10$ pounds. Corresponding deflection is:

$$0.00315 \times (33)^2 = 3.43 \text{ inches.}$$

Formulas can easily be deduced making it possible to use the accompanying table for other classes of elliptic springs than those of the semi-elliptic type with all leaves fully graduated.

The formulas for the semi-elliptic spring with all leaves graduated are:

$$P = \frac{2\,S\,n\,b\,h^2}{3\,L} \text{ and } f = \frac{S\,L^2}{4\,E\,h}.$$

To find the values of P_u given in the table, insert $S = 80,000$, $n = 1$, $b = 1$, $h =$ the value given in the first column in the table, and $L = 1$. To find the values of f_u, insert in the second formula $S = 80,000$, $L = 1$, $E = 25,400,000$, and $h =$ the value given in the first column in the table.

Now if the values in the table are to be used for other springs, constants can be deduced by which the table values may be multiplied.

For a semi-elliptic spring with a portion of the leaves graduated the load P remains the same as for a spring with all leaves graduated. The formula for the deflection, however, is:

$$f = \frac{1}{2\,(2 + r)} \times \frac{S\,L^2}{E\,h}.$$

The values in the table, therefore, must be multiplied by

$$\frac{2}{(2 + r)} \times L^2 \text{ to find the deflection for any given combina-}$$

tion full leaf and graduated spring of effective length L.

For a full elliptic spring with all leaves graduated, P still remains the same as for a semi-elliptic spring, but f doubles its value, or:

$$f = \frac{S\,L^2}{2\,E\,h}.$$

The values in the table, therefore, in this case must be multiplied by $2\,L^2$.

For the full elliptic spring with part of the leaves only graduated, the load P remains the same as before, but the deflection is twice that of a semi-elliptic spring:

$$f = \frac{1}{2\,(2 + r)} \times \frac{2\,S\,L^2}{E\,h} = \frac{S\,L^2}{(2 + r)\,E\,h}.$$

In this case, then, the values for the deflection in the table are to be multiplied by $\dfrac{4}{2 + r} \times L^2$.

The flexibility of a spring is the amount of deflection as compared to the load. This may be expressed as so many inches deflection per hundred pounds, or y.

Example:—Assume a full-elliptic, fully graduated spring, where

$S = 80,000$,
$E = 25,400,000$,
$b = 1\frac{3}{4}$ inch,
$n = 4$,
$h = \frac{1}{4}$ inch,
$L = 30$ inches.

Then the safe load equals:

$$P = 4 \times 1\tfrac{3}{4} \times \frac{3333.33}{30} = 778 \text{ pounds.}$$

And the deflection equals:

$$f = 30^2 \times 2 \times 0.00315 = 5.67 \text{ inches.}$$

Then,

$$y = \frac{5.67}{778} \times 100 = 0.73 \text{ inch.}$$

On the other hand, assume that the thickness and number of leaves is unknown. Then we have:

$P = 778$ pounds,
$S = 80,000$,
$E = 25,400,000$,
$b = 1\frac{3}{4}$ inch,
$L = 30$ inches,
$y = 0.73$ inch.
Then

$$f = \frac{778}{100} \times 0.73 = 5.67 \text{ inches.}$$

But $f = 2\,f_u\,L^2$, where f_u is the constant for deflection in the accompanying table:
Hence,

$$f_u = \frac{f}{2\,L^2} = \frac{5.67}{1,800} = 0.00315.$$

The thickness of steel in the table which corresponds to this value of f_u is one-fourth inch.

The number of leaves is found by using P_u, thus,

Load on one leaf, one inch wide is:

$$\frac{3333.333}{30} = 111.11 \text{ pounds.}$$

Load on one leaf one and three-quarter wide is:

$$111.11 \times 1\tfrac{3}{4} = 194.25.$$

Number of leaves is then,

$$\frac{778}{194.25} = 4.$$

The present calculation makes no allowance for the leaves of a spring varying in thickness. Where such springs are used, the deflection of the different leaves will not be uniform. Hence, in such springs also a suitable initial "pull" should exist, and such springs should be estimated by a general formula based upon a combination of different cantilevers, thus making allowance for different depths of cantilevers. It is much better to use springs composed of but one thickness of leaves, as the combination of different thicknesses adds a complexity scarcely necessary.

Results obtained from fully graduated full elliptic springs would seem to show that the action of the friction between the leaves is not great enough to seriously affect the bending action, in that the formulas give results agreeing very closely with actual conditions.

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ELECTRIC VS. STEAM LOCOMOTIVES

Almost at the same time as the experiments carried on for several years past on the Swedish state railways have led the railway administration in that country to install electric traction on one of the state railways for both passenger and freight traffic, it is decided by the Swiss railway administration to return to the use of steam locomotives on one railway line after two years trial with electric locomotives. The main reason for this appears to be that electric operation proved more costly than expected, the excess of cost of electric operation over that of steam operation being about $1,000 a year per mile of road electrically operated. The results obtained by the Swiss railway administration are significant, inasmuch as Switzerland is especially adapted for electric operation of the country's railways. The abundant water power available makes it possible to generate electric current as cheaply as conceivable. Coal, on the other hand, is costly in Switzerland, due to the fact that all coal must be imported. The results of the experimental operation in Switzerland indicate that electric traction will be profitable only on the lines having very heavy grades or dense traffic. If this is the case in a country where water power can be obtained in abundance and where coal is costly, it indicates that the existence of the steam locomotive is placed on a very firm foundation in countries where water power is comparatively scarce and coal abundant, as, for instance, in the United States.

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A chair in aerial navigation has been established at the East London College of the London University. Prof. A. P. Thurston will have charge of this department and lecture on aerial navigation and subjects connected with this science.

CUTTING SQUARE HOLES ON A KEYSEATING MACHINE

ETHAN VIALL*

The making of square holes of any considerable length in tough metal is always something of a problem, especially if the holes are to be of uniform size within very narrow limits. As a general rule, such holes would be made by running a number of broaches through a drilled hole, but a method is in use at the shop of Blood Brothers Machine Co., Kalamazoo,
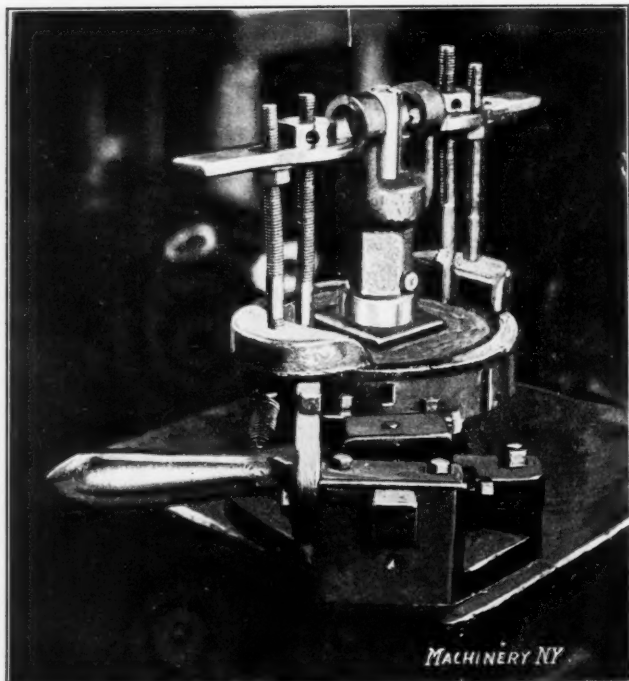

Fig. 1. Indexing Fixture used on Keyseating Machine while Squaring Holes

Mich., where holes 1¼ inch square and 4 inches long are made in a very tough grade of steel by first drilling a hole the same diameter as the side of the square wanted, cutting out the corners on a Mitts & Merrill keyseater and then finishing the hole by forcing a short sizing-broach down through it.

The part in which this square hole is made is the hub of a fork for a universal joint, manufactured by the firm mentioned. After the fork is drilled it is placed on a keyseater fitted with the indexing fixture shown in Fig. 1, and one corner of the hole cut out. The fixture is then indexed a quarter turn, the next corner cut, and so on until the hole is squared
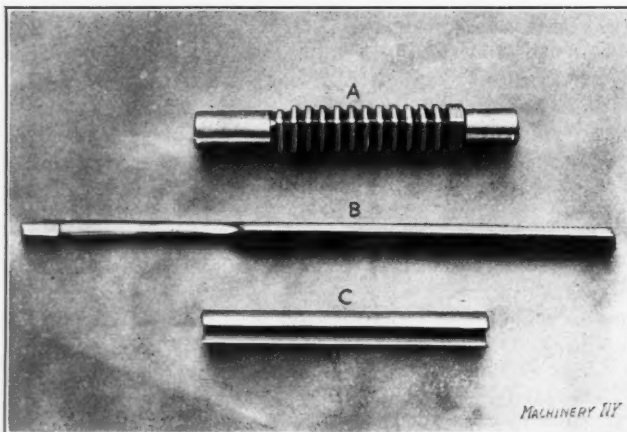

Fig. 2. Broach, Cutter and Cutter Guide used in making Square Holes

within a few thousandths of the size wanted. The work is then placed in a small hydraulic press and a sizing broach run through as mentioned before.

The cutter used to cut out the corners is shown at B, Fig. 2, the cutter guide at C and the broach at A. In Fig. 3 are shown samples of the work, after it has been drilled as at A, cut out as at B, and broached as at C.

In cutting out the hole, enough of the round is left to act as a guide for the pilot on the broach. Those who have ever

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used a broach of this type know of its tendency to crowd over to one side when it is not started perfectly straight. By having a pilot-guide, this tendency is largely overcome and the hole is started and kept straight with little difficulty.

Some will no doubt think that the keyseater method of rough squaring the holes is slower than draw-broaching, but all things being considered, the use of a keyseater is, in a case like this, probably cheaper owing to the amount and toughness of the metal to be removed. At least two and perhaps three draw-broaches would have to be used, and the actual time would be about the same, while the cost of the broaches would be very largely in excess of cutters. By the method just described, from twelve to fifteen holes are finished per hour, a liberal supply of soapwater being used while cutting.

The push-broaches used for this job are about fourteen inches in length with a 2½- or 3-inch pilot and a 2-inch shank. Beginning with the first tooth, the size increases 0.001 inch for each one up to the last or sizing tooth. This is left twice as wide across the top as the others as shown at A, Fig. 2. The other teeth are ¼ inch wide with a ¼-inch flute, and the face or outside is ground perfectly straight and parallel with the center line of the tool, giving absolutely no clearance. The cutting edge, however, is hooked under just enough to cause it to cut a nice curling chip, all sharpening, of course, being done on the cutting edge and not on the outside, as that would change the size. By giving the teeth no outside clearance, the tendency to "creep" in case the metal were a little softer on one side, is minimized, and with the aid of the pilot a perfectly straight hole is made.

Beside cheapness, another advantage claimed for this method, is that there is no tearing of the metal, perfectly
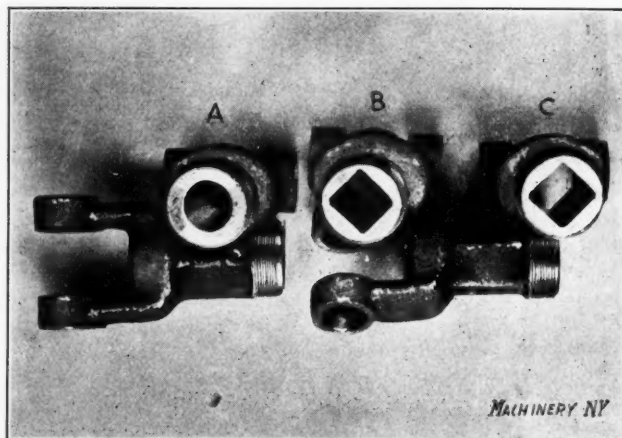

Fig. 3. Universal Joint Forks, showing Drilled, Machined, and Broached Holes

smooth holes being obtained. Of course, full-sized square holes could be made without the use of a broach, but more time would undoubtedly be taken in getting as accurate results.

The keyseater may also be used to cut triangular, hexagon, octagon or almost any other shaped holes by simply grinding a cutter to the proper outline, and if any quantity were wanted, an indexing fixture similar to the one shown could be easily made.

* * *

The Norwegian Parliament has just passed a measure of great industrial importance, relating to the future exploitation of the country's water power. This act recognizes distinctly the rights of the whole nation to the country's national resources in the form of available water power. Concessions for use may be given for a term of from 60 to 80 years, but at the end of the concession the water fall, with regulating works connected therewith, and the sites and rights required for the exploitation of the water power and for the power station, become the property of the state with full ownership and without compensation; this latter provision gives to the state a compensation for the privilege conferred upon the private exploiting company during the period of the concession. Water falls of a capacity of less than 1,000 horse-power are excepted from the rulings of this act.

TO CALCULATE THE DEFLECTION OF A SPECIAL STEEL SECTION*

MARTIN JOACHIMSON†

The problem presented in the following, although taken from actual practice, has been selected as a specimen for calculations relating to special steel sections, because it involves all the calculations which ordinarily occur in such cases. When sections are built up of plates and angles, the areas, center of gravity and moment of inertia of the parts can be found in the hand-books published by the various steel companies; this of course simplifies the calculations.

The problem in the present case is as follows: How much will the proposed section, shown in the accompanying engraving, deflect under a total load of 400 pounds, if this load be
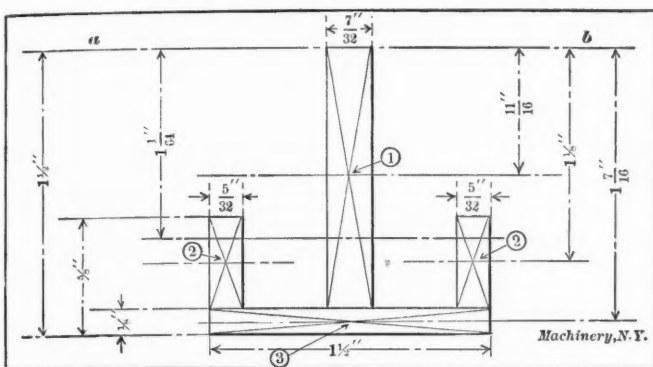
Section of Built-up Beam, used as Example for the Calculation of Moment of Inertia and Deflection

uniformly distributed over the total distance between the supports, which is 6 feet? The formula for the deflection of the beam is:

$$D = \frac{5\,Wl^3}{384\,EI}$$

in which $D =$ deflection in inches,

$W =$ total load $= 400$ pounds $+$ weight of beam,
$l =$ length between supports in inches $= 72$ inches,
$E =$ modulus of elasticity for steel $= 29,000,000$,
$I =$ moment of inertia of section.

This formula was given in MACHINERY's Data Sheet No. 48, September, 1905.

The weight of the beam and the moment of inertia of the section must now be obtained before the deflection can be calculated. The general formula for the moment of inertia with respect to any given axis is:

$$I = \Sigma\,(ad^2 + i)$$

in which $a =$ area of each part making up the complete section,

$d =$ distance from the center of gravity of each part to the axis with respect to which the moment of inertia is required,
$i =$ moment of inertia of each part.

The Greek letter Σ (sigma) indicates that the sum of the moments of inertia of each part with respect to the axis required gives the total moment of inertia.

The position of the neutral axis must be determined before we can determine the moment of inertia with respect to this axis. The neutral axis of the whole section passes through the center of gravity of the section. The location of the center of gravity is determined with respect to the line ab by the formula:

$$\text{distance of center of gravity from line } ab = \frac{\Sigma\,(ad)}{A}$$

in which $a =$ area of each part making up the complete section,

$d =$ distance from the center of gravity of each part to line ab,
$A =$ total area of section.

indicates in this case, as above, that the sum of the areas of the various parts multiplied by the distance of the center of gravity of each part to the line ab, is required. The use of this formula will be understood from the following simple calculation:

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* With Data Sheet Supplement.
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First find the total area of the section. The different rectangles in the section of the sample beam are called (1), (2), (3) and (4), respectively. The areas of the sections are then as follows:

$$\text{Area (1)} = \frac{7}{32} \times 1\tfrac{3}{8} = 0.300781$$

$$\text{Area (2)} = \frac{5}{32} \times \tfrac{1}{2} = 0.078125$$

$$\text{Area (2)} = \frac{5}{32} \times \tfrac{1}{2} = 0.078125$$

$$\text{Area (3)} = \frac{1}{8} \times 1\tfrac{1}{2} = 0.1875$$

The areas are found from the tables in the accompanying Data Sheet Supplement; in the case where 7/32 is to be multiplied by 1⅜, of course, 7/32 is multiplied by 1, and then by ⅜, and these two products are added. Now to find the weight of the section per foot, multiply the sum of the areas obtained by the factor 3.4 for steel, as a steel bar weighs 3.4 pounds per foot when the section is one inch square. Then the weight per foot equals:

$$0.64453 \times 3.4 = 2.19 \text{ pounds,}$$

and the weight of the whole beam 6 feet long equals:

$$2.19 \times 6 = 13.14 \text{ pounds.}$$

Now to find the distance of the center of gravity of the section from the line ab, multiply the area of each section by the distance of its center of gravity from the line ab, thus:

area	×	distance	= moment
0.30078	×	11/16	= 0.20678
0.07812	×	1⅛	= 0.08788
0.07812	×	1⅛	= 0.08788
0.1875	×	1 7/16	= 0.26952
0.64452			0.65206

Now adding the four moments obtained gives us 0.65206 as shown, which equals the quantity $\Sigma\,(ad)$. Dividing this sum by the total area, which equals 0.64452 gives us the distance of the center of gravity of the whole section from the line ab:

$$\frac{0.65206}{0.64452} = \frac{65}{64} = 1\,1/64 \text{ inch, very nearly.}$$

We are now ready to find the moment of inertia of the section. The moment of inertia of a rectangular section is found by the formula:

$$I = \frac{bh^3}{12}$$

in which h equals the height of the rectangle and b the width or breadth, the height meaning the dimension which is at right angles to the neutral axis. This formula is found in any engineering hand-book. The individual moments of inertia of each rectangular section are now found with respect to their own neutral axis, as below:

$$\frac{\frac{7}{32} \times (1\tfrac{3}{8})^3}{12} = 0.04739$$

$$2 \times \frac{\frac{5}{32} \times (\tfrac{1}{2})^3}{12} = 0.00325$$

$$\frac{1\tfrac{1}{2} \times (\tfrac{1}{8})^3}{12} = 0.00024$$

Having now found the moment of inertia of each section we find the quantity $ad^2 + i$ for each of the sections with relation to the neutral axis of the section. The sum of these various quantities gives us the total moment of inertia, I.

a	d	d^2	i	$ad^2 + i$
0.30078	$\frac{21}{64}$	0.1077	0.04739	0.07976
0.15625	$\frac{7}{64}$	0.01196	0.00325	0.00512

a	d	d^2	i	$ad^2 + i$
0.1875	$\dfrac{27}{64}$	0.1780	0.00024	0.03361

$$I = 0.11849$$

We can now find the deflection by inserting our values in the original formula for the deflection, W being 413.14 pounds and $I = 0.1185$.

$$D = \frac{5 \times 413.14 \times 72^3}{384 \times 29,000,000 \times 0.1185} = 0.5847 \text{ inch.}$$

This deflection, of course, would be too much for practical purposes.

* * *

BOILERS AND CHIMNEYS*†

A. WIND‡

The writer read with great interest the article entitled "Simple Method of Stack Design," published in the August, 1909, issue of MACHINERY. The expression "horse-power" of a boiler, used in this article, is an expression that is not customary in England. The term horse-power for a boiler seems to me very vague, because the boiler when used for two different types of engines would give a very great difference in the amount of power that may be obtained from it. A boiler, for instance, may be able to evaporate say 6,000 pounds of water per hour at 120 pounds working pressure. Assuming twenty pounds of steam for every horse-power, this boiler would be a 300 horse-power boiler; but if the boiler were supplying steam to an engine exhausting into the air and working under unfavorable conditions, 35 pounds of steam per horse-power might be required. In this case the boiler would be of only 170 horse-power. Again, a boiler may not be used for raising steam for engine driving, but it may be used for boiling purposes, as in paper mills, creosoting plants or celluloid works; then the term horse-power would convey an altogether wrong idea.

I find, therefore, that it is better to follow the custom used in England and on the Continent, of speaking of boilers as being built to evaporate so many pounds of water per hour under ordinary circumstances. At the works where the writer is employed this method of designating boilers applies as well to water tube, Lancashire, Cornish and multi-tubular boilers. Of course, it must be understood that a boiler being built to evaporate 6,000 pounds of water per hour when fired with good coal by hand, would be able to evaporate 8,000 pounds of water per hour, or thereabouts, when fired with a mechanical stoker and fed with pre-heated feed water.

[Our correspondent apparently has an erroneous idea as regards the meaning of a boiler horse-power, as this expression is used in the United States. The Centennial standard boiler horse-power adopted by the American Society of Mechanical Engineers in 1884, is defined as an evaporation of 30 pounds of water into dry steam under a pressure of 70 pounds per square inch above atmosphere from feed water at a temperature of 100 degrees F., or the evaporation of 34½ pounds of water from feed water at a temperature of 212 degrees F. into steam of the same temperature. This standard is equal to 33,305 B. T. U. per hour.—EDITOR.]

As regards the size of chimneys, the writer would say that the draft that is necessary for hand firing will almost without exception be sufficient when firing the boiler with an ordinary mechanical stoker. In the accompanying Data Sheet Supplement heights and diameters of chimneys for different kinds of boilers are given. This table is based upon the grate area of the boiler, assuming the burning of from 20 to 25 pounds of coal per square foot of grate per hour. The size of the grate in many instances will vary very little with the length of the boiler. In the works where the writer is employed the same grate is put into a Lancashire boiler 25 feet long as in one 30 feet long. This applies also to Cornish and multi-tubular boilers. When two or more boilers are worked together it is not necessary to calculate the size of the chimney for the total combined grate area of all the boil-

ers, as it is very seldom that all the boilers are fired in all furnaces at exactly the same time. Therefore, a greater number of boilers permits of a comparatively smaller size of chimney. The table in the accompanying Data Sheet Supplement gives the diameters of boilers, grate areas and the diameters and heights of chimneys for any number of boilers from one to five, in the case of the Cornish type, one to fifteen in the case of the Lancashire type, and one to ten in the case of the multi-tubular boilers. In each case the height of the chimney is taken to be 20 times its diameter.

Where forced draft or induced draft plants are installed, the size of chimneys can, of course, be considerably reduced. Each given size of chimney would prove sufficient for 33 per cent greater capacity than shown in the table, when such draft is employed. To determine the size of the chimney for six boilers with induced draft, for example, select the chimney given in the table corresponding to four boilers.

The sizes of chimneys given in this table correspond to the ordinary practice in England and on the European continent. It may, of course, differ slightly from that customary in the United States, but the writer thinks that, nevertheless, this table may be of interest to steam engineers in America.

* * *

RECIPROCITY

W L. CHENEY*

"I will put in one of your machines if you will put in one of mine"; how often we hear this expression!

It is all rot, and time it was so understood. The only legitimate reason for buying a machine is that the buyer will be better off for having bought it. The interest of the buyer of a machine is in what the machine will earn for him; therefore he should buy the one which is best for his purpose, and it follows that a man who buys a machine which is *not* best for his purpose, simply because the other fellow will buy one of *his* machines, is worse than silly, because his profit is soon eaten up by the increased cost of what the inferior machine produces, and after that it is all loss. This is so simple a proposition that it is axiomatic, and there is, therefore, no use arguing with a man who cannot see it at first glance when it is brought to his attention.

The same principle applies to different *grades* of machines of approximately similar design. Either one machine *is* better designed and made, will do more and better work, and is in the repair shop less than another, or it is *not;* if it *is*, why buy the other because of a few dollars saving in first cost, and go on losing profits ever after?

The mistake is often made of assuming that the interest of the seller of a machine is only in the profit which the sale brings; but the seller has a further interest and *this is identical with the interest of the buyer*, because the profit on the sale of a machine ends with the sale, and no concern can live on the profit from *one* sale. The man who habitually sells machines which are not best for the user's purposes has a hard row to hoe. Nothing helps sales like the "good word" from the satisfied user. So, what can be said that is strong enough against the folly of two men who make "exchanges" and "trade deals" for no other reason than their blind worship of the fetish of "reciprocity?"

* * *

Attention is called in the *Electrotechnische Zeitschrift* to the fact that the static charge of the cover-glass of electrical instruments is the source of many errors in electrical observations. The longer the pointer, the nearer it is to the glass, the feebler the directive force of the instrument, and the drier the atmosphere, the greater will be the error in the reading. In a dry warm room instruments have been known to indicate wrong as much as twenty per cent when touched with the dry hand. By drawing a piece of soft leather across the glass of a galvanometer, deflections up to five per cent may be produced. The deflections are not lasting, of course, but it may be as much as an hour before the pointer will again indicate correctly. Errors are produced, for instance, when cleaning the glass by wiping off the dust. As a preventative for the difficulty, it is stated that breathing upon the glass will eliminate the static charge.

* See MACHINERY, August, 1909, engineering edition : Simple Method of Stack Design.
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MACHINING CYLINDERS AND PISTONS FOR AUTOMOBILE ENGINES*

HAROLD WHITING SLAUSON†

Less than ten years ago, an automobile race held in France was won by a certain car propelled by a two-cylinder gasoline motor developing four horse-power. Today, duplicates of this motor, so far as number of cylinders, bore and stroke are concerned, are made by the thousand in one of the large French factories; but these motors now develop *twelve* horse-power—an increase of 200 per cent! This is indeed a striking illustration of the improvements in design and the rapid strides in shop and manufacturing methods made in the auto-
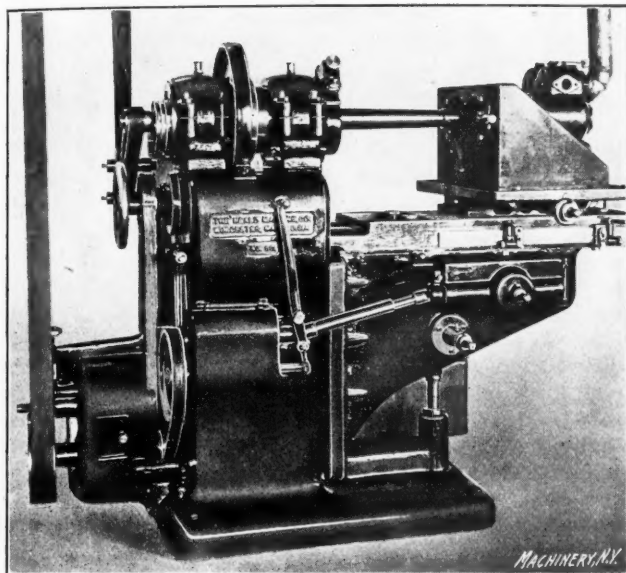
Fig. 1. Heald Grinder used in Premier Factory, showing Exhaust Attachment for Drawing off the Iron and Emery Dust

mobile industry during the past decade and it serves to show why the modern motor car renders such vastly better service than did its ancestor of ten or twelve years ago.

Much of this increased efficiency has doubtless been due to improved shop methods and tools whereby a far better fit of pistons and rings in the cylinder has been made possible. Good compression and the ability of the piston rings to prevent the escape of gas during the comparatively short time that the so-called explosion lasts is of such vital importance to the internal combustion motor that it is doubtful if the square pistons of the time of Watt would have served the purpose for any prime mover in which the source of energy is located in the cylinder itself. Owing to the higher temperature and pressure generally found in the internal combustion motor cylinder, the rings must be tighter and the piston looser than is the case with the steam engine, while the higher speed of the former power plant necessitates the minutest attention to details of workmanship and material to prevent undue wear of the moving parts. This higher speed also requires a more perfect balance of piston, connecting-rod and crank-shaft, and it is the practice in one of the leading American automobile factories to allow a margin of but ¼ ounce between the weight of any two pistons in any of the motors turned out.

There may be said to be almost as great a variety of methods in use for the preparation of the cylinder and piston of a modern automobile engine as there are makes of cars on the market. There are a number of different ways for performing the operations of boring, grinding and reaming cylinders and for grinding, "lapping" and "running in" pistons and rings, and nearly every possible combination of the processes for treating these two principal parts of a motor will be found in the numerous automobile factories of this country. One factory may bore the cylinders and grind both cylinders and pistons; another may treat the former in the

same manner, but prefer to "lap in" the pistons; a third may ream the cylinders and both grind and "run in" the pistons; while still another may perform all four operations. When to these are added the drilling and tapping of holes in the casting, the facing off of the base, valve seats and the like, and the reaming of the pockets, it is small wonder that every cylinder on one of the well-known makes of cars has received nine different operations at the hands of as many different artisans before it is ready for its installation as a part of the completed motor.

In many of the shops special machine tools have been designed for the purpose of performing but a single operation on a number of cylinders at once. On the other hand, however, excellent work is performed in those factories in which attachments have been improvised for use on regular tools and machines such as will be found in any well-equipped machine shop, and the quality of the output will compare favorably with that of the concerns employing the most modern special equipment. Horizontal boring mills in a variety of forms are used in the majority of factories for giving the rough and finishing cuts to the cylinder castings. In some of the factories which make engines having the cylinders cast in pairs, a double mill is used having two bars which bore both cylinders at once. Several of these are in use in the Peerless factory at Cleveland, and each is equipped with a turret on which the casting is held while the cylinders are being bored. Another pair may be set in place while the operation of boring is in progress on the first set, and when these are completed, the turret is turned and the new casting is in position to be worked.

The rough and finishing cuts in the boring mill were formerly the only machine operations that the interior of the cylinder received, and even today some of the manufacturers do not consider it necessary to grind the walls. When the cylinders are not ground after being bored, it is necessary
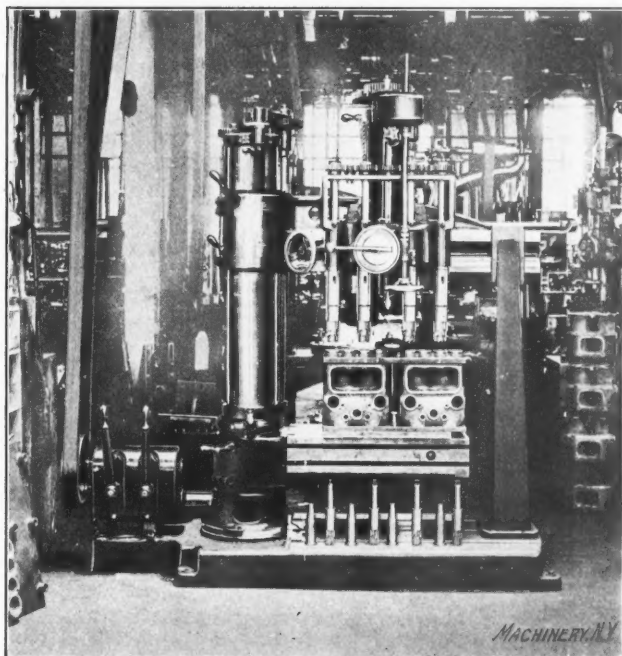

Fig. 2. "American" Radial Drill in Winton Factory, with Four-spindle Attachment for Reaming Automobile Cylinders

that the motor shall be run under belt power for a considerable time before the walls are worn sufficiently smooth to permit the engine to operate efficiently under its own power. In lieu of grinding, graphite has been found to produce good results when worked into the cylinder walls by the piston. The small particles of this substance fill every minute pore and hole left in the cylinder walls by the boring tool, and produce an almost perfectly smooth surface. As graphite is unaffected by heat, the high temperatures of the combustion chamber do not injure or alter it and it remains in its place in the cylinder walls for a practically indefinite period.

All of the motors for the Gaeth automobile, made in Cleveland, are bored on a lathe, and the results speak highly for the methods of treating cylinders employed in this shop. The cylinders are cast in pairs, and when bored, each pair

is held in place on a fixture which is attached to the face-plate of the lathe. This fixture is so arranged that either cylinder may be turned into the proper position for boring without the necessity of removal from the faceplate. When one of the pair is finished, the other cylinder may be swung into position with only a few seconds' delay, and as no re-adjustment is necessary, it is certain that the two borings in the casting will be absolutely uniform. After the finishing cut of the boring tool has brought the cylinders to within about 0.010 inch of their proper diameter, the same lathe is converted into a grinding machine by the addition of a small electric motor and emery wheel, and the cylinders are then ground to exact size.

The emery wheel is attached to the end of a long spindle, which is in reality an extension of the armature of the motor, and the whole apparatus is clamped rigidly to the tool car-
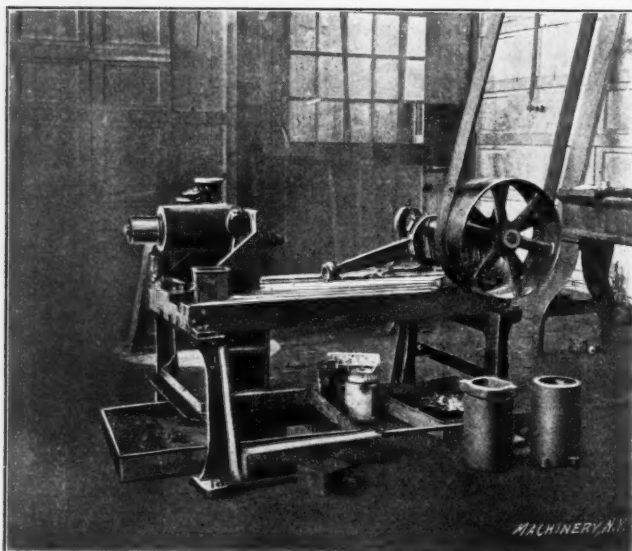

Fig. 3. Piston Lapping Machine in Marmon Factory, showing Connecting-rod Disconnected at Ball-and-socket Joint*

riage of the lathe. The motor is run at high speed, while the back gear of the lathe is used to turn the cylinder cast-ing slowly in the opposite direction. The length of the spin-dle on the motor allows the emery wheel to travel the entire distance of the cylinder walls to be ground, without danger of interference between casting and tool or carriage. Al-though this method of converting a lathe into a grinder is by no means new to machine shops, it is not common in auto-mobile factory practice.

The cylinder of a modern automobile must of necessity be designed with such a small factor of safety in order to bring the whole machine down to the required lightness, that the utmost care must be taken in boring and grinding to prevent any weakening of the walls which might produce disastrous results if the pressure in the combustion chamber should become too great. Although these cylinder castings are con-structed of the finest quality of gray iron, too deep a cut or too rapid speed in the boring mill may produce sufficient heat to strain the material unduly, and although all the fac-tories exercise the greatest care in this respect, the methods employed in two of the shops to prevent such an occurrence are worthy of note.

In the factory in which the Marmon car is made, in Indian-apolis, the cylinder casting is placed on the boring mill in a special fixture. This fixture contains intake and outlet water pipes with terminals which are attached to the respec-tive plugs of the cooling system of the cylinder. When the boring mill starts its cut on the cylinder wall, water is run through the fixture and the jacket of the casting, thus keep-ing the material at an even temperature throughout the opera-tion. It has been found that, with this method, the boring mill can be run at a higher speed and take a deeper cut with no attendant danger of inducing strains in the cylinder walls.

An entirely different practice is employed at the Premier factory, also located at Indianapolis. This method is a *cure*, whereas that described above is a *prevention*. After the

* For a more detailed view of the opposite side of this machine and additional information, see the article: Automobile Factory Practice, published elsewhere in this number.

first rough cut has been taken on the boring mill, the cylin-der is removed and taken to the heat treating room where it is thoroughly annealed. This process is repeated after the final or finishing cut, and while it is not probable that the metal has received any strains due to the excessive genera-tion of heat in the boring mill, any internal strains that may have been set up will surely be removed by these heat treat-ments.

After these operations, the cylinder is placed in the fix-ture on the Heald grinding machine and, as shown in one of the accompanying illustrations, Fig. 1, is connected at its valve openings to an air suction pipe which serves to remove all emery and iron dust formed in the casting. This type of grinder is in use in many of the leading automobile factories. The emery wheel is mounted on the end of a spindle which revolves at high speed on its axis. The bearing of this spin-dle is set in an adjustable eccentric which serves to give a circular sweep to the emery wheel in the opposite direction to that of its rotation. In other words, the eccentricity of the bearing of the spindle causes the outer point of the periphery of the emery wheel to describe a circle of the same diameter as that to which it is desired to grind the cylinder. An idler pulley, actuated by a cam, moves with the eccentric and serves to keep at the proper tension the belt which drives the spindle. [See MACHINERY, April, 1908.]

Many of the factories making motors having cylinders of small diameter and stroke accomplish the results attained by the finish-boring cut and grinding by means of the single operation of reaming. For this purpose, a large drill press, a lathe or a vertical boring mill with revolving table is used. (See Fig. 2.) It is a simpler operation than any of those already described, requires the use of fewer tools and ma-chines and, in cylinders of small size, produces very satis-factory results.

Opinions seem to differ among many of the automobile manufacturers in regard to the necessity of grinding pistons. To say that, in all the leading factories, all the pistons are ground, would be unfair, for many a car, whose proved reli-ability and efficiency place it among the leading makes, has been designed and built in a shop in which the piston has gone directly from the lathe to the cylinder. Some makers claim that, inasmuch as the contact of the piston itself with the cylinder walls is not an essential in preventing leakage, it is useless to bestow the extra time and labor of grinding upon it—especially if the emery wheel has left the wall of the cylinder with a hard, glazed surface which would wear the rings to a perfect fit after a few hours' run of the motor under belt power. Others claim that too much attention can-not be bestowed upon these important moving parts of an internal combustion engine, and hence grind both the piston and the rings before installation in the motor.

The piston casting, of course, is turned, bored and the ring grooves cut to size in a lathe. The process following this operation in use in the Gaeth factory is interesting and unique in the extreme and, so far as the writer has been able to ascertain, is employed in this establishment exclu-sively. After the piston has left the lathe and the rings have been fitted to their grooves by the usual method, a special cement is applied to the rings, which holds them firmly in place. After this cement has hardened, the piston is taken to the lathe, the emery wheel attached and the surface ground down to exact size. The rings have been cemented in place so that their notched ends are closed around the pins in the grooves and, in consequence, they are ground down flush with the surface of the piston at all points on their outer cir-cumference.

When this grinding is completed, only the closest scrutiny will reveal several very fine lines which indicate the sides of the rings. These lines defining the rings cannot be de-tected by the most sensitive touch, and it is evident that the whole surface is, to all intents and purposes, absolutely smooth. After the rings have been thus fitted, the cement is dissolved, the rings spring out to their normal positions and the piston is ready for installation in its cylinder.

As evidence of the attention given to detail by the leading automobile designers, the dimensions of every piston as it is

finished in this factory are worthy of note. Instead of being of the same diameter throughout its entire length, the piston is tapered for a distance of one inch down from its upper end. Although this difference in diameter is small, amounting to 0.020 inch for the lower half of this tapered part and an additional 0.007 inch for the upper half, it has been found to be sufficient to allow for the greater expansion which occurs at this end of the piston, caused by its proximity to the combustion chamber and the intense heat generated therein.

A Norton Grinding Co.'s grinding machine is used in the Premier factory for piston grinding, and is typical of the machines used for this purpose in many of the best automobile shops. It is a too familiar sight in most of the best-equipped machine shops to require description.

In the majority of cases, when the piston and rings are not ground, they are "lapped in." This consists in moving the piston and rings up and down in the cylinder, under belt power attached to the flywheel, for several hours, and at the same time introducing an abrasive material between the moving surfaces. At the end of this operation, the rings and all parts of the piston which may have come in contact with the cylinder walls will have been worn smooth and to a practically perfect fit. The motor is then tested on the blocks under its own power with a variable load attached in the form of a dynamometer. When the engine has been thoroughly "tuned up" and all adjustments made, it is ready for installation in the chassis, and finally the completed car, with the exception of the stock body, is taken out for a severe and thorough road test. This road test generally covers a couple of hundred miles at the least, and when this is completed, it is almost certain that the rings will have been worn to as perfect a fit as though they had been ground.

At the Marmon factory, a special machine, Fig. 3, is used for lapping in the piston rings, which, while simple, is very effective. An iron casting is bored and ground to the exact size of the cylinder diameter and is mounted on a fixture at one end of a short bed. Directly opposite the opening in this casting and mounted on a shaft with axis at right angles to the stroke of the cylinder, is an eccentric and connecting-rod. The free end of this connecting-rod terminates in a ball-and-socket joint which can be attached to the connecting-rod of the piston to be lapped. The shaft on which the eccentric is mounted is driven by belt power and a reciprocating motion is thus communicated to the piston in the casting. The ball-and-socket joint allows the piston to be rotated by hand during its travel in the casting, thus bringing all parts of its surface in contact with every point on the cylinder walls. A hole is drilled in the upper side of the cylinder casting and a funnel attached through which may be fed the abrasive mixture—generally composed of finely powdered emery and oil. The fixture in which this casting is mounted will accommodate a pair of the motor cylinders, in which the pistons may be lapped, but it is simpler and more convenient, as a rule, to use this iron block ground exactly to the proper bore.

It is manifestly impossible in an article of this length to describe all of the variations of methods for the treatment of gas engine cylinders and pistons in use in the numerous automobile factories in this country. The practices dealt with in the foregoing paragraphs, however, represent the methods used in many of the leading factories. The impression gained from a recent inspection of the majority of the leading factories brings the writer to the conclusion that shop practices are becoming more uniform and that, as the industry has advanced, the number of different methods for producing the best work with the attendant expenditure of a minimum amount of time and labor has greatly decreased.

* * *

The large stern frame for the new White Star liner *Olympic* was lately transported from Darlington to Belfast. It weighs 70 tons and measures 68 feet by 22 feet. The traffic on the North-Eastern Railway had to be stopped while the frame was transported by the railroad from Darlington to West Hartlepool, owing to the fact that the width of the frame prevented cars from passing on the adjoining tracks.

AUTOMOBILE FACTORY PRACTICE*

NORDYKE & MARMON CO., INDIANAPOLIS. IND.

ETHAN VIALL†

The Nordyke & Marmon Co. has manufactured flour and cereal mill machinery for nearly sixty years, and in this business is well known the world over. In 1905 the company placed an air-cooled motor car on the market and continued this type of car until 1908. A change was then made to the production of water-cooled motor cars and since then rapid strides have been made in the matter of enlarged and improved manufacturing facilities. At present the company is manufacturing one chassis, known as the "Marmon Thirty-two" (now in its second season), and the parts have reached a standardization that is almost perfect.
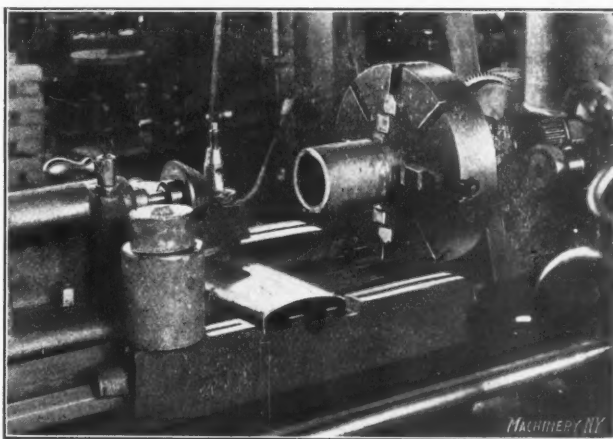

Fig. 1. First Operation on Pistons: Breaking the Inside Edge, Roughing Outside and Cutting Off Chucking Plug

While the shop equipment is not as extensive as in some other automobile factories, it is large and very complete, including modern tools of the best makes. The tool, jig and fixture equipment is unusually good, showing on every hand evidence of considerable skill and ingenuity. Profiting by the mistakes of others, the company has been enabled to cut out a lot of expensive experimenting, so that its car and its shop practice compare very favorably with those of firms who have been building automobiles for a longer period. The general superintendent follows the plan of calling the various
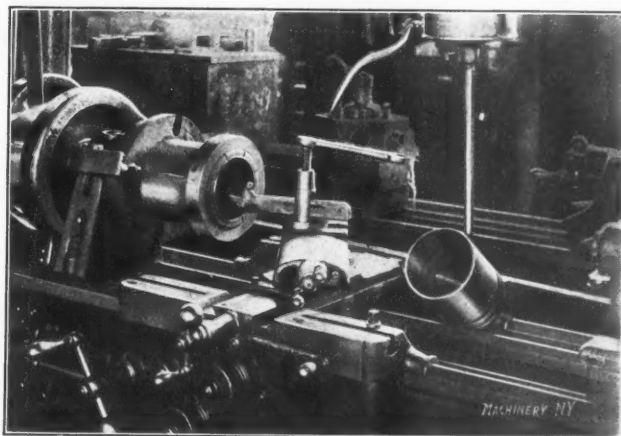

Fig. 2. Second and Third Operations: Boring Inside, Truing Edge, Facing and Centering End

foremen together whenever a new tool or machine is being designed and allowing each one to take a "whack at it," discussing the good or bad points until by the time they are ready to make it, the rough, impractical spots have all been taken off. So as a rule, the tool or machine, when made, works just as desired, without any great change or alteration being necessary, for if there are flaws anywhere, a half dozen or more keen, bright, mechanical foremen are pretty apt to detect them long before they leave the designer's hands for the toolroom. Then, too, the general foreman had been in the automobile business with one of the oldest and largest

concerns in the world from its inception, until he took his present position, and, in consequence, he knows how good tools should be used and how parts should be handled to the best advantage.

A rather unusual, though good plan of the foreman, is to have jigs and fixtures made, when possible, to fit more than
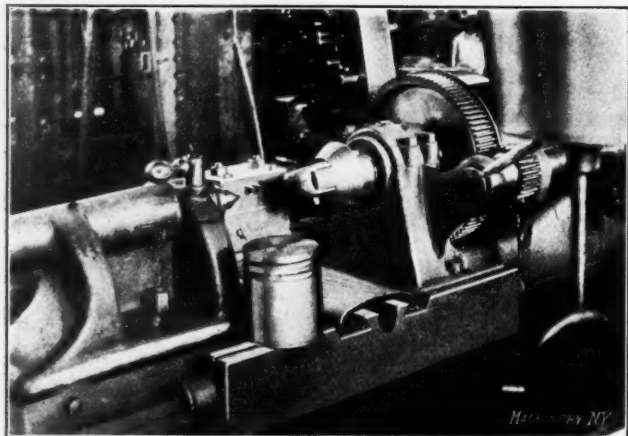

Fig. 3. Fourth Operation: Turning Outside and Cutting Ring Grooves

one class of machines. For instance, a jig intended for use in a screw machine may also be used in a lathe or a drill-press, or a lathe fixture may be used on a boring mill, or perhaps, in some cases, on a milling machine also. In this way a few machines of one class are not overcrowded while others
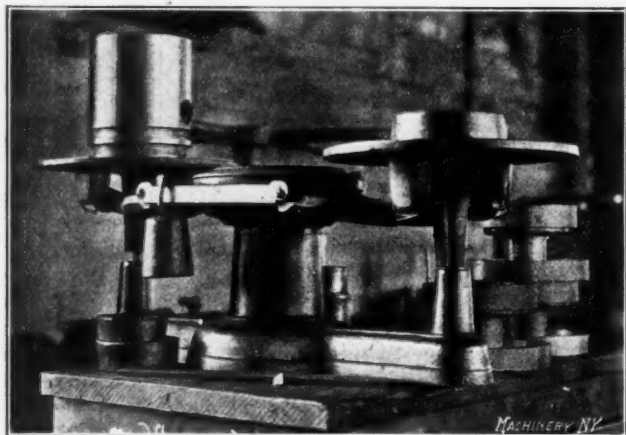
Fig. 4. Scales on which the Pistons are weighed

are idle, because the parts to be machined can easily be placed where most convenient and promptly finished, where otherwise they might be held up for days, as so frequently is the case.

Everywhere, hand feed is dispensed with if practical, and power feed used. Especially is this noticeable in the drilling
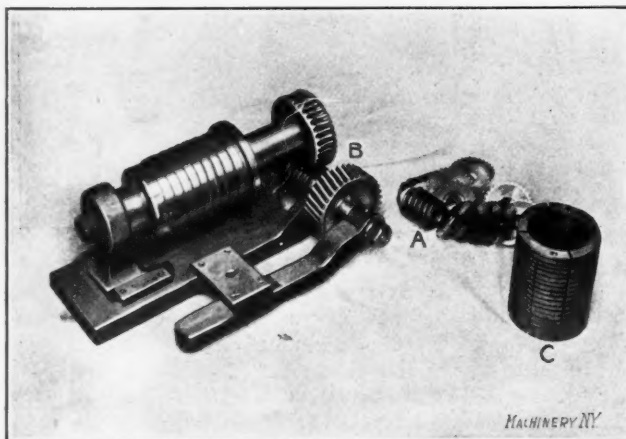

Fig. 5. Milling Fixture and Tools for Cutting off Piston Rings

operations, and the result is an almost uniform rate of output, which is not true where hand feed is used, as then the rate is highest when the man is fresh and decreases as he tires.

Piston castings are made with an extension of reduced diameter instead of the usual flange or lugs. They are first placed in a regular lathe chuck as shown in Fig. 1, the inside

edge beveled slightly for the large tail center, and the outside rough turned. The casting is then cut off, leaving the extension in the chuck, and placed in the hollow chuck shown in Fig. 2. The inside is then bored out to the wrist-pin bosses; the inside edge trued up; the casting turned end for end; and the closed end surfaced off and centered. The piston is then put into a lathe fitted, as in Fig. 3, with a large center and a floating driver which goes in between the wrist-pin bosses; the grooves are next cut and the outside trued up. From this point on, the piston goes through the processes common to the majority of automobile shops, which have been repeatedly described in these columns. Finally it is brought to a certain weight by testing it on balance scales as in Fig. 4, superfluous metal being removed until it balances.

Piston rings are made by first truing up a cast iron sleeve and then placing this sleeve on an expanding arbor and cutting it into rings with a gang of milling saws. The method is similar to that employed in the Stevens-Duryea shop, as
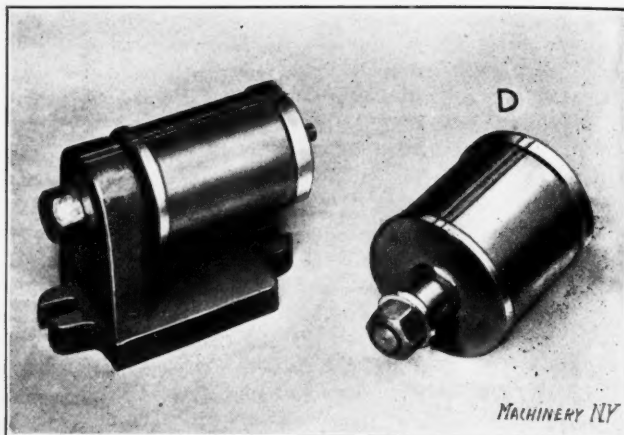

Fig. 6. Milling Fixture for Splitting Piston Rings

described in the October number, except that here the work is done on a regular instead of a vertical, milling machine, the fixture and parts shown in Fig. 5 being used. In using this fixture, the worm A is placed on the arbor with the milling saws and meshes with the gear B, causing the expanding
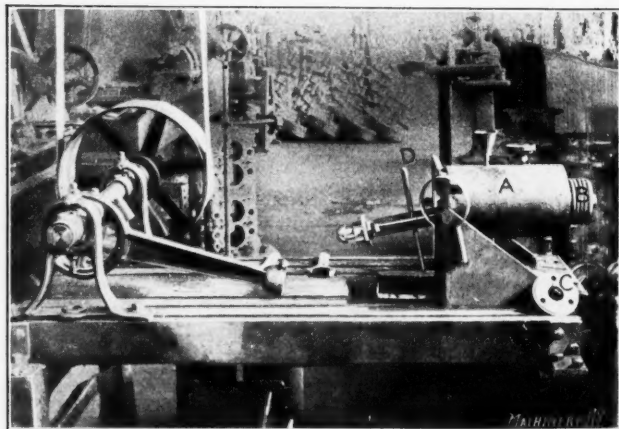

Fig. 7. Piston Ring Lapping Machine

arbor to rotate as the cut proceeds. Different expanding sleeves or bushings are provided for the various sizes of piston rings, one of which is shown at C. The rings are split straight across by two saws while clamped between the flanges of the fixture shown in Fig. 6. Extra clamping mandrels, like D, which fit the table bracket, are used for the various sizes.

Lapping the Piston Rings

Instead of lapping the piston rings in the engine cylinder in which they are to be used, as is commonly done, the rings are lapped in the machine shown in Fig. 7. The cylinder used is a cast-iron sleeve A, which is bored to the exact size of the cylinders, and is easily replaced. The rings are placed on the false piston B and held by screwing on the flange C, which merely keeps them from coming off the piston and does not clamp them tight enough to prevent their expanding. As the machine moves the piston and its load of rings

back and forth in the cylinder, it is revolved by hand by means of the handle *D*, the connecting-rod joint being made so as to allow the piston to be turned easily. While the operator turns the rings, he feeds emery and oil through the funnels in the top of the cylinder.

Timing the Fly-wheels

Nowhere have I seen a better arrangement for marking the timing points on fly-wheels. Instead of the usual "cut-and-try" method of marking after the fly-wheel is in place, it is here marked before assembling on the shaft. Two of the bolt holes in the center of the fly-wheel are drilled farther apart than the others, in a drill jig, and these serve as guides when placing the wheel on the flange pins of the marking
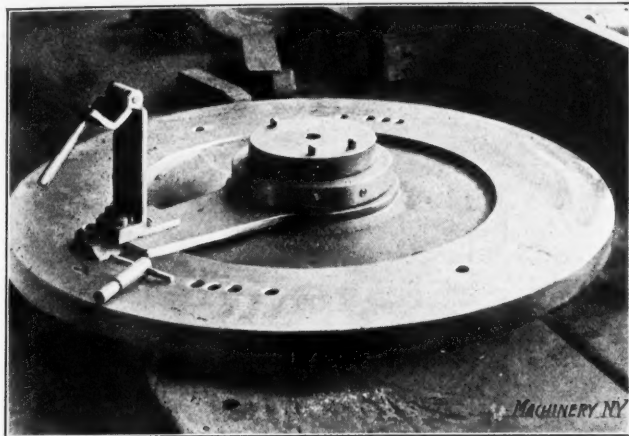

Fig. 8. Fly-wheel Timing Gage

gage shown in Fig. 8, and also make it impossible for the assembler to put it on wrong. The fly-wheel is placed on the gage as shown in Fig. 9 and is, of course, stationary while the arm or marking guide is movable. This arm is set at the various points by a hardened pin passing through its base and fitting into bushed holes in the circular bed of the gage. The respective markings are stamped into the rim of the wheel with steel stamps lettered to indicate: "inlet closed," "exhaust closed," etc.

Balancing Fly-wheels

Fly-wheels are balanced after the fashion of balancing a millstone or a limber cockhead drive by spinning them on the
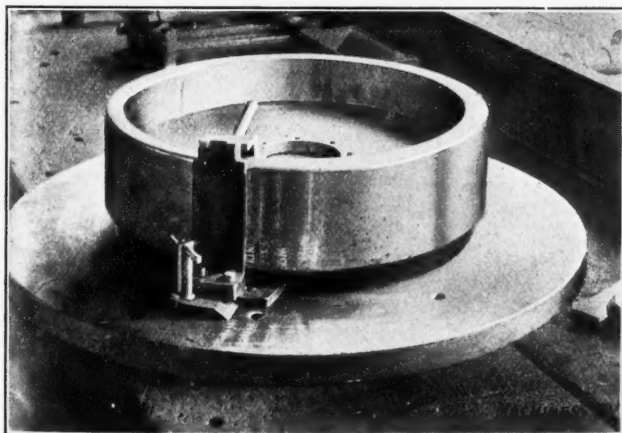

Fig. 9. Timing Gage with Fly-wheel in Position

machine shown in Fig. 10. The rim is marked with chalk and then enough metal drilled out to balance it. An experienced man can tell pretty accurately how much to drill out and where, by the appearance of the marks. Fig. 11 shows how the machine looks with the fly-wheel removed. The flanged center to which the fly-wheel is bolted, is still in place. Fig. 12 shows the machine with this center removed and set up on edge so as to show the bottom of it and the cockeye in the center. The cockhead on which the flanged center rests, and the two drive pins, are also shown. By this arrangement the fly-wheel is given the necessary freedom of movement to enable it to seek its balance while in rapid motion. The wheel is also put in standing balance on the crank-shaft.

Rolling Bronze Bushings

The crank ends of connecting-rods are bushed with Parson's white bronze, and the final sizing is done, not by reaming, but by rolling with the tool shown in Fig. 13. The connecting-rod is held in the jig shown, which has a guide bushing
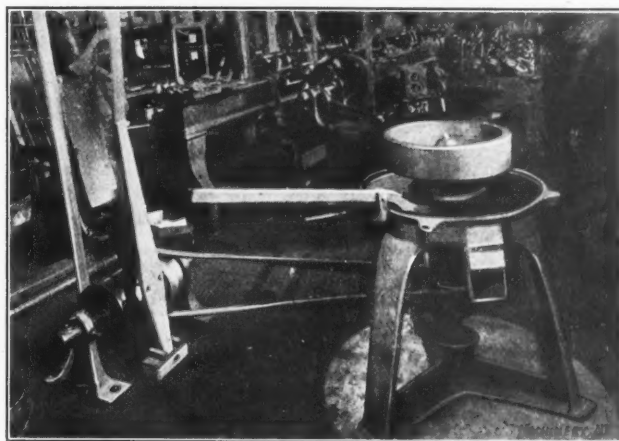

Fig. 10. Fly-wheel Balancing Machine with Wheel in Place

in the bottom for the pilot of the roller tool, at the right. This tool is so made that it may be adjusted for size, to a limited extent. The rollers are highly polished, hardened steel rollers with rounded ends, held in place by a cupped retaining ring at each end and supported by the steel center of the tool body. Not only does this tool give an excellent
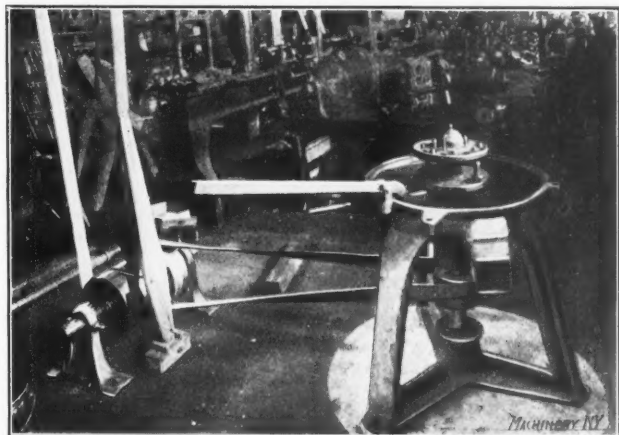

Fig. 11. Balancing Machine with Wheel Removed

finish to the bearing surface, but it also presses the metal firmly into place. Through an oversight, an unbushed connecting-rod was used when photographing, but the connecting-rod shown on the balancing device (Fig. 14), shows the style of bushing used. This device was made for balancing
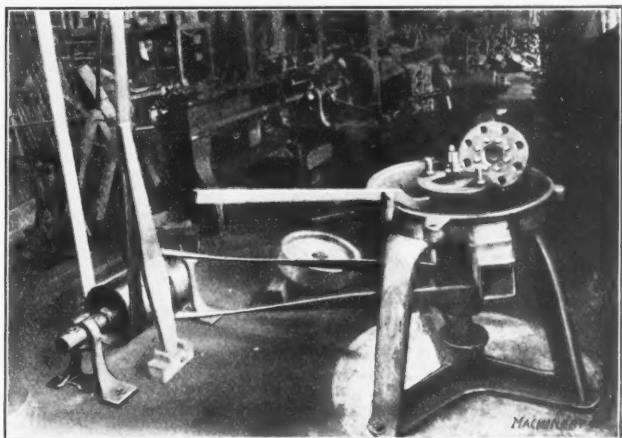

Fig. 12. Balancing Machine with Floating Disk Removed

connecting-rods so that the weight would be properly distributed.

Casting Bronze Ends onto Steel Axles

Phosphor-bronze ends are cast on the pressed steel rear axles, which prior to this operation appear as in Fig. 15. The

casting is done by standing them on end in a mold and pouring molten phosphor-bronze around the ends; they then appear as in Fig. 16, the bronze castings being shown with runners and risers still in place. As a rule, in fusing one metal onto another, considerable extra metal is run through the mold, but in this case it is not necessary, as a perfect union takes place between the tubular steel axle and the

is notched on one side just enough to go over the ball arm nicely. The forging on which the ball is to be finished, is held in a chuck with formed jaws, and the tool is fed straight onto the forged ball, cutting it to size quickly and smoothly and leaving no teat on the end, as so many other tools used for this purpose do. No rake is necessary on this tool, but it
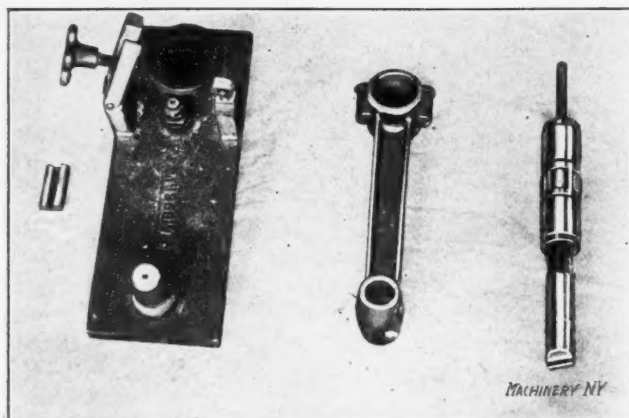

Fig. 13. Rolling Tool and Chuck for Sizing Bronze Connecting-rod Bushings
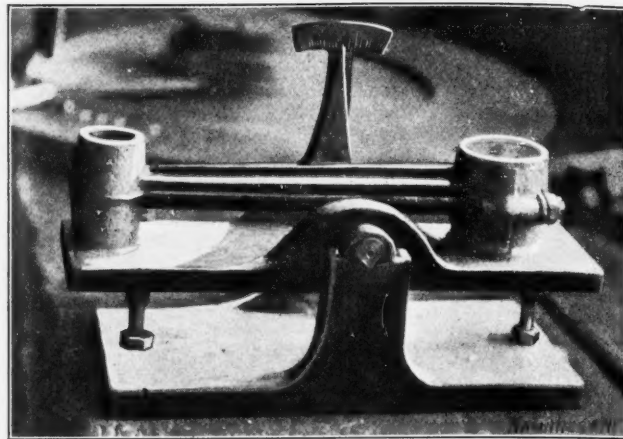

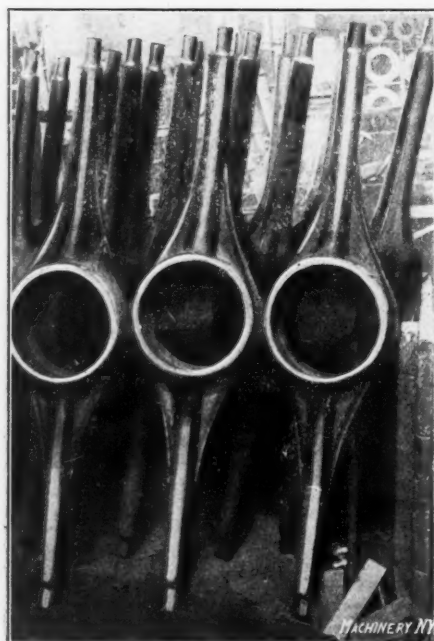Fig. 14. Scale for Balancing Connecting-rods

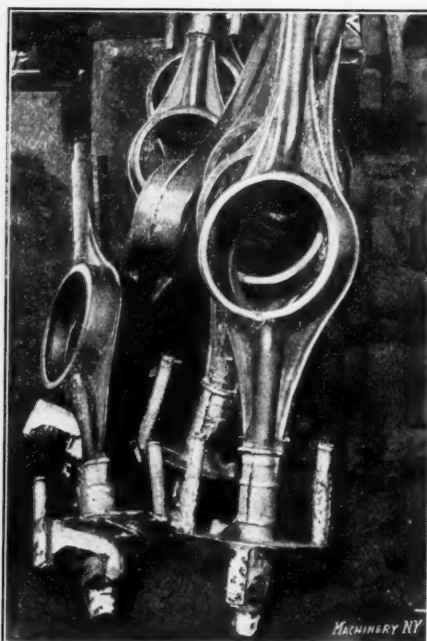Fig. 15. Rear Axles before Phosphor-bronze Ends are cast on

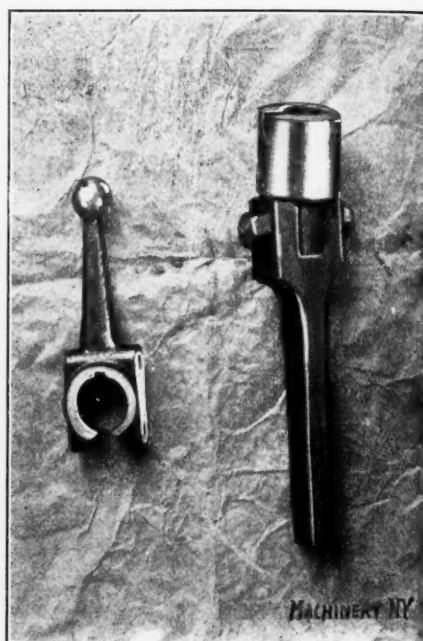Fig. 16. View of Rear Axles after the Bronze Ends are cast

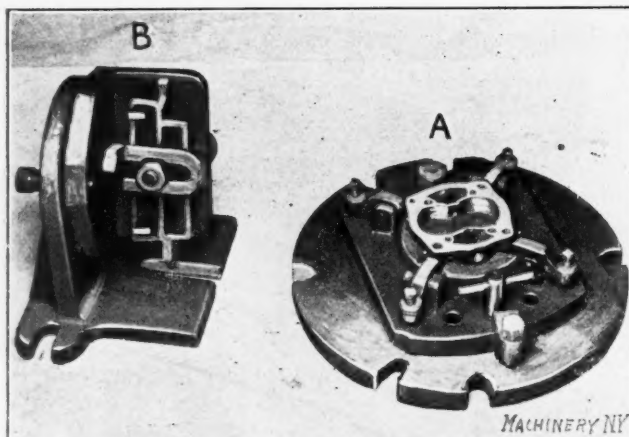Fig. 17. Ball Turning Tool and Sample of its Work

Fig. 18. Fixture for Milling Quadrants, and Oil Pump Casing

Fig. 19. Fixtures used in Surfacing Part of Muffler and Cutting Brake Band

bronze without extra metal other than shown. After one end has been cast on, the axle is reversed and the other end packed in a fresh mold and cast as before.

Turning Balls

The simplest ball turning tool imaginable is shown in Fig. 17. It consists simply of a hardened cylindrical piece of steel fastened to a shank for the tool-post, as illustrated. The hole inside the cutter is just the size of the ball wanted, and it

should be ground perfectly square on the end, which can easily be done by holding the end against the side of an emery wheel if no other means is at hand. This tool is, of course, only used for finishing or smoothing up balls already formed, such as forged ball-cranks, ball-levers or parts of universal joints, and it is not intended for cutting balls from the solid.

At *A*. Fig. 18, is shown an indexing jig for holding the body

Fig. 20. Lathe Turret Tool-post for Holding Four Tools
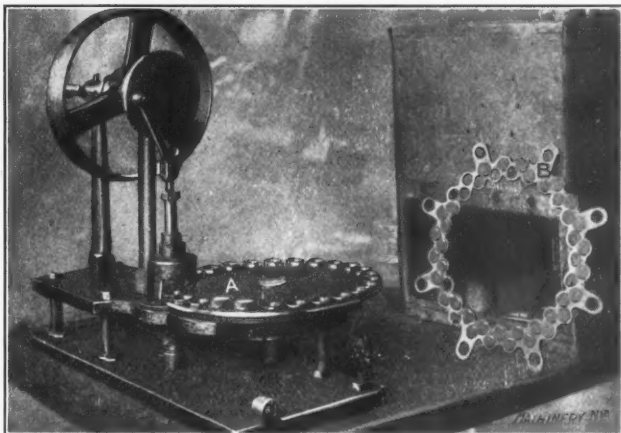
Fig. 21. Friction Disk Cork-inserting Machine
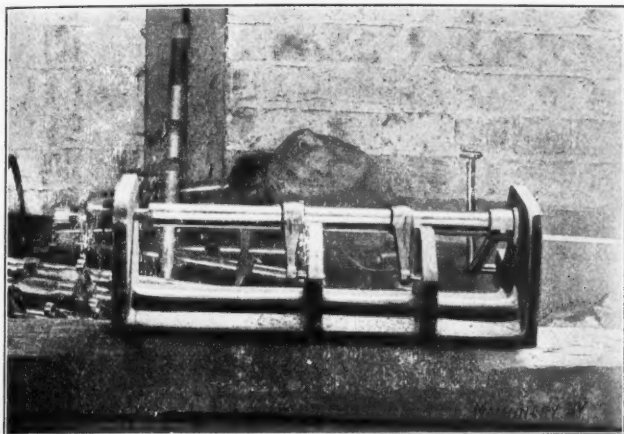
Fig. 22. Jig in which Foot-lever Pin-holes are drilled

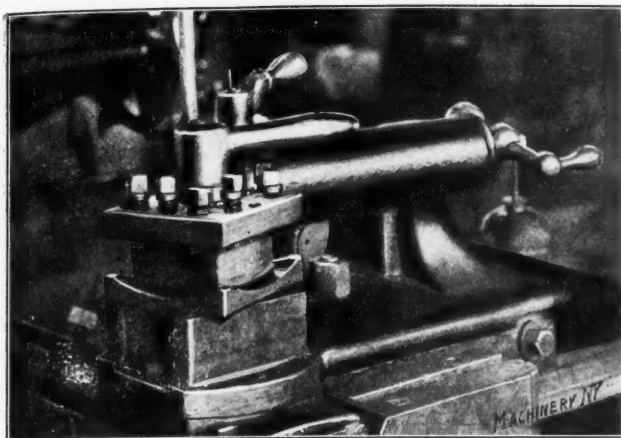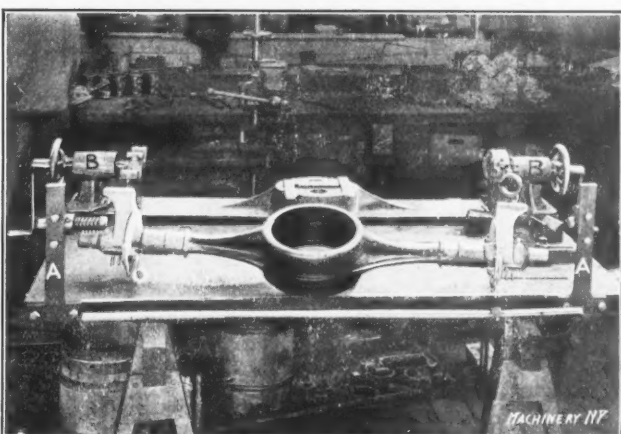Fig. 23. Centers for Testing and Reaming Rear Axles
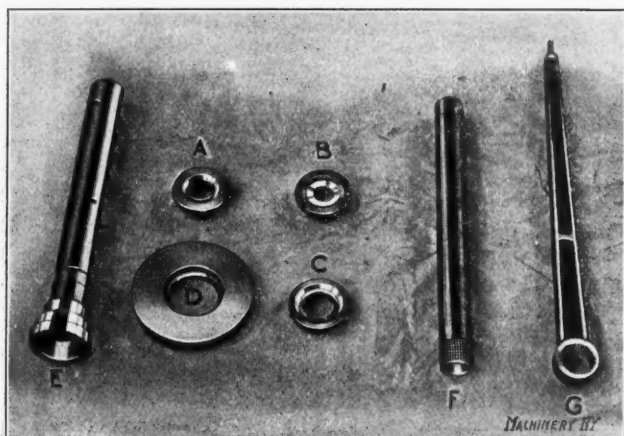
Fig. 24. Tools for Corrugating Ends of Shafts, and Sample of Work
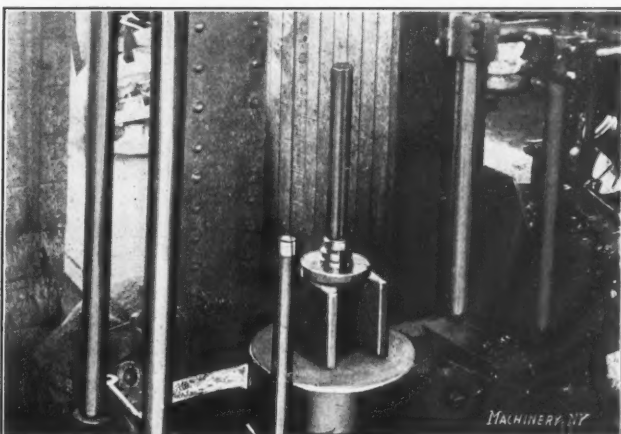
Fig. 25. Hydraulic Press in which Shaft Ends are corrugated
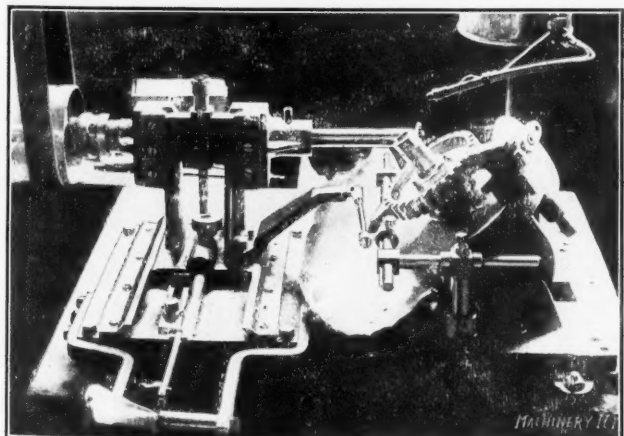
Fig. 26. Change Gear Tooth-chamfering Machine
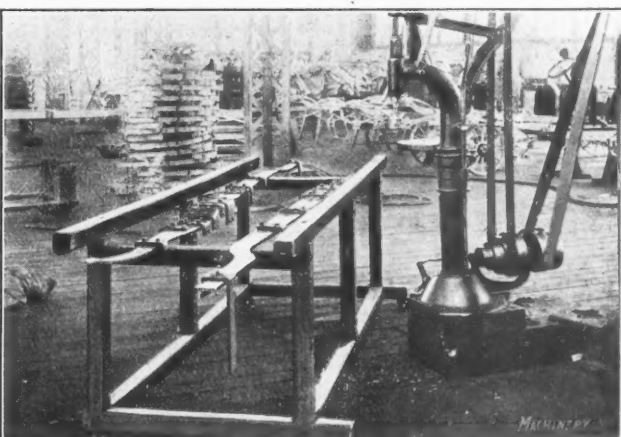
Fig. 27. Frame Drilling Stand and Jigs

of a small oil gear-pump while facing it off and boring out the recesses for the gears. The indexing of the work from one center to the other is common enough, but the method of clamping the casting in the jig (which is plainly shown)

is not so well known, though it is very effective and leaves no parts projecting above the surface of the casting to interfere with the tool. At *B* is another indexing jig used to hold change gear lever quadrants while milling the ends with an

end mill. In Fig. 19 the jig C is another application of the indexing idea for turning two circular parts not concentric. The part shown is the cast-iron end of a muffler drum. Owing to the irregular shape of part of the casting, it is rather a difficult piece to hold, as the only regular part on it is the thin flange, the upper part of which must be turned. The clamping has been successfully accomplished, however, by using "posts" on the upper, inner edge of which has been turned a shallow L-shaped circular groove, into which the flange of the casting fits. These posts, though of cast iron, will stand a certain amount of springing and are tightened onto the rim of the casting by means of the set-screws in the
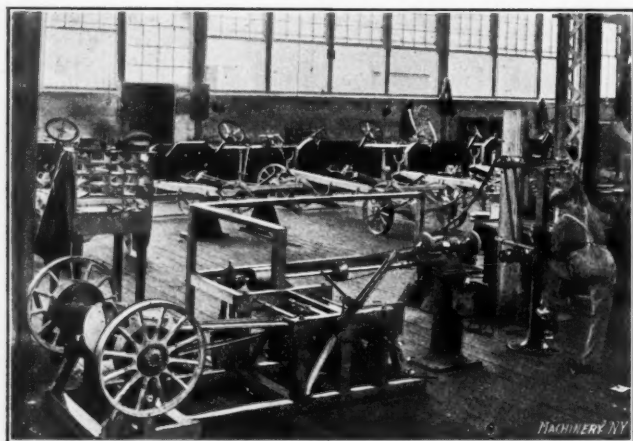
Fig. 28. Assembling Stands for Rear Axle Mechanism

heavier posts back of them. The jig D is used to hold brake rings while sawing out the part E. The cuts are taken as indicated in the engraving. As they are radial, only one milling saw is used. After the first cut is made, the handle F is moved over against the other stop for the last cut.

Many of the lathes in the shop have been fitted with the handy four-tool turrets shown in Fig. 20. Rockers are fitted to the bottoms of the holders to center the tools properly. These turrets save tool changing and the consequent annoyance and delay on many lathe jobs.

Formerly the clutches on Marmon cars were made with cork inserts. While this type of friction disk is no longer used here, the machine used to put the corks into the disks will be of interest because of its simplicity and the rapidity with which it did the work. Guide plates like A (Fig. 21), with flaring holes in them corresponding to the holes in the
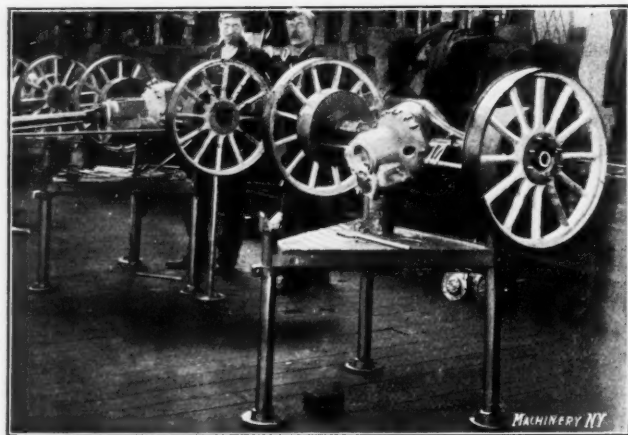

Fig. 29. Apparatus for Testing Rear Axle Mechanism

friction plates into which corks were to be inserted, were used, and corks were placed into these holes and automatically fed under the plunger which pushed them down into the disk beneath. A friction plate with a double row of corks, is shown at B, but these were put in by using a taper tube and hand punch, none of the style for which the machine was intended being in stock.

Fig. 22 is a jig for holding foot levers in the proper position on the shaft while drilling and pinning, previous to brazing.

Fig. 23 shows a fixture used for testing rear axles and center reaming them. At A. A. are the centers on which the

axle is spun when it comes from the foundry after having the bronze ends cast on, in order to see if it is straight enough for turning. If it isn't, it is sprung or bent into correct alignment before it is strapped into place at B, B and the ends center reamed, ready for turning in a lathe.

Instead of keying or just pinning levers onto the ends of the rocker-shafts in the usual way, all end levers have the hole corrugated and are pressed onto the corrugated end of the shaft and then pinned. The hole in the lever is corrugated by broaching, and the shaft ends are made to correspond by using dies like A, B and C, Fig. 24. A die of the right size is placed in the collar D, and the end of the guide tube E is placed on top. The shaft is then forced down the required distance through the die, in a hydraulic press, as shown in Fig. 25. A shaft and lever is shown at F and G, respectively, in Fig. 24.

Sliding gears have the ends of the teeth chamfered in the semi-automatic machine shown in Fig. 26. In this machine the feeding is done by hand, but the indexing is automatic, the gear being moved one tooth as the feed lever is drawn back.

Frame sides are drilled while clamped to the stands shown in Fig. 27, the drill jigs lying on top of the stand being used.

The stands used while assembling the rear axle mechanism, which in this case includes both the change gears and differential, are shown in Fig. 28, and in Fig. 29, is shown the apparatus used to test out the assembled mechanism. A very thorough try-out is given the various parts before allowing them to be placed in a machine.

* * *

NEED OF A GOOD APPRENTICESHIP SYSTEM

J. F. RICHMAN*

Every day finds us getting farther and farther away from a satisfactory solution of the apprenticeship problem. In this age of high speed and rapid production, the heads of manufacturing companies have neglected this one important stone—the foundation of the future army of mechanics. Only about one man in fifty applying for a position, can truthfully say that he is an all-around machinist. The employers are not entirely to blame; employes are responsible to a greater or less degree (judging by years of experience) as the following illustration will show:

Sam has served his apprenticeship and worked as a journeyman for fifteen or twenty years, and is capable of doing any job in the factory; on account of his skill and industry, he is given a job on the milling machine at a rate of 35 cents per hour. Joe comes in from the farm and is put on a similar machine and rated at 17½ cents per hour. In three or four months Joe goes to his foreman and demands a raise. The foreman remonstrates with him on account of his inexperience. He replies, in a sort of braggadocious style, "Well, I am doing as much as Sam and he is getting 35 cents," and he threatens to leave. The foreman, rather than break in a new man, grants him the raise. In a few months the same process is repeated, until Joe is receiving the same amount as Sam. Then Joe requests a change, but is informed that he has no practical knowledge of other machine tools. Joe is aware, by this time, that he cannot command 35 cents except on a special class of work, and is not willing to work for lower wages; consequently he remains a milling machine hand all his life.

The writer has seen many such cases and has them under his supervision. On the other hand, manufacturers have found that when a man is kept on one job continually, he can accomplish better results than an all-around man working on all types of machine tools, and making no one a specialty. For this reason they desire to make specialists as much as possible.

I would like to ask the mechanical world where we are going to get our foremen, superintendents, and managers in the future? It is true that the technical man is coming to the front; but he, too, must have the practical experience, as well as the support of the well-trained, all-around mechanics.

* Address: Care of Hudson Motor Car Co., Detroit, Mich.

THE UNITED STATES CREAM SEPARATOR

ITS DESIGN AND MANUFACTURE

RALPH E. FLANDERS[*]

The village of Bellows Falls, Vt., was foreordained by Nature, when she laid out the geography of New England. For the past forty odd miles the Connecticut River has been pursuing a placid and unobstructed course, but here it finds the way barred by an outcropping ledge, set like a dam, between high hills on each side. Over and through this ledge the water has worn a rough, crooked passage. The first pulp mills were built here many years ago, the owners being drawn by the fine water power, and by the vast drives of spruce logs, which each spring are floated from far-away forests on the Canada border, to mills in this and other towns nearer the centers of civilization.

The town is famous for its bridges, as well as for its pulp mills. The latter are located on an island between the main bed of the stream and the power canal, which at ordinary times carries the greater part of the flow. Means of communication

Among these bridges may be found fine examples of almost every one of the important types in use. Spanning the river above the island is shown, in Fig. 1, a famous two-hinged arch which was described in the various civil engineering papers at the time of its erection a few years ago. In Fig. 2 are shown two older examples, the one in the rear being a solid masonry arch, while the one in front is an excellent example of the interesting structures found the whole length of the Connecticut valley, built by local "bridgewrights" as they may be called. This one has a lattice frame and a central pier, and is built of timber. Others of these homemade bridges have Howe truss frames, while still others combine the lattice frame with a wooden arch as a reinforcement.

The writer has seen bridges of this kind in which not an ounce of iron was used. All the joints were mortised and tenoned, and fastened with wooden pins. The floor boards were pegged to the beams. The roof boards were pegged to the rafters, and even the hewn shingles were fastened in the same way. Perhaps the longest of these Connecticut River bridges is the one at Springfield, Mass., which many readers of MACHINERY must have seen. Some one has compared them to huge
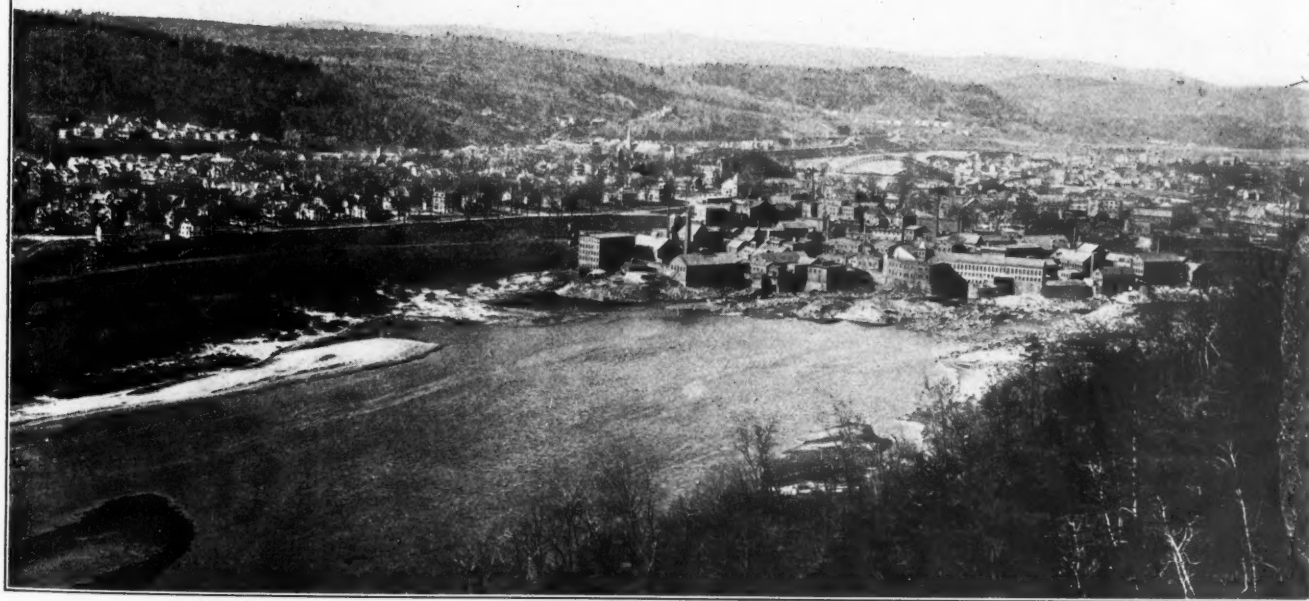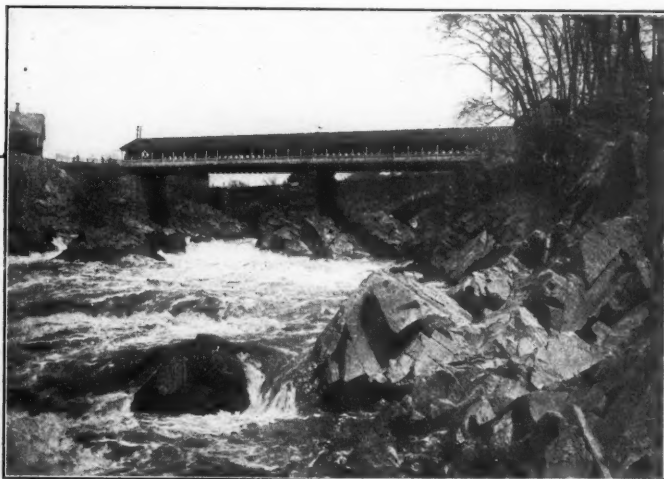
Figs. 1 and 2. Bellows Falls, Vt., Famous for its Pulp Mills, Bridges and Cream Separators. Two Examples of Bridge Construction: The Homemade Toll Bridge and the Masonry Railway Bridge

have to be provided to reach this island from both sides. Furthermore, the town is an important railroad center. The main Connecticut valley line of the Boston & Maine R.R. crosses the river here, the station being located on the island. An important branch of the Fitchburg division climbs down from the hills on the New Hampshire-side, while a main line of the Rutland Railroad climbs up into the still higher hills of the Vermont side. All these lines of transportation, with the local electric car line, require no less than sixteen bridges in the little one-quarter mile square space about the island.

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caterpillars crawling across the stream. Anyone who has seen one of them from the distance, with its long, dark and oftentimes crooked body, its stumpy legs resting in the flowing stream, will appreciate the aptness of the comparison.

The United States Cream Separator

All this is digression, however. The chief thing of interest to the mechanic in Bellows Falls, is the plant of the Vermont Farm Machine Co., whose best known product is the United States separator, used by farmers throughout the country for separating milk into cream and skimmed milk. Through the kindness of the management the writer was permitted to visit the shop and study the various operations which go

into the making of their product. The work done here proved to be of such interest as to suggest the writing of this article.

Mechanics in the past hundred years have added tremendously to the productiveness of the individual farmer. The mowing machine, the reaper, the threshing machine, the portable engine and other tools have enabled him to cultivate tens and hundreds of acres with better care than he could formerly give to one. The cream separator is a later addition to this list of farm machinery. It has only come into common use
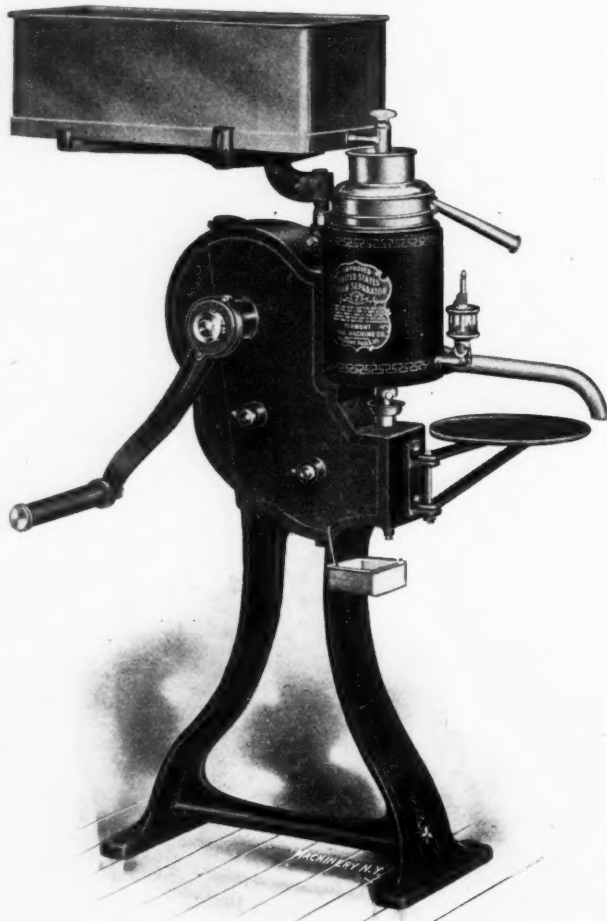

Fig. 3. The United States Cream Separator

in the past twenty years and is still in process of improvement. It enables the farmer to separate the cream immediately after milking, without waiting for the slow and uncertain influence of gravity. The cream is skimmed much cleaner than by the old process, leaving less of it in the milk. The thickness of the cream is under absolute control and is of a better quality, being cleaned from the dirt which is almost sure to find its way into the milk pail. It leaves the skimmed milk fresh and in the best condition to feed to growing cattle.

All these are agricultural features, however. From a mechanical standpoint the separator is interesting because it requires the highest grade of work of any machine used on the farm, being on a par in this particular with the best grade of machine tools. At the same time it has to be so designed and constructed as to be used by people comparatively unskilled, without danger of seriously injuring the mechanism. The important points of durability and easy replacement of parts in case of breakage must also be provided for.

Description of the Separator

The United States separator is shown in elevation and section in Figs. 3 and 4. The milk is emptied into pan A, from which it flows through a faucet into the feed cup B. A float in this feed cup, entering the faucet, serves to regulate the flow so as to keep an even level in the cup and a consequent even rate of flow through the machine. From B the milk passes down into a rapidly revolving bowl C, whose construction will be described later. Here the cream is separated from the skimmed milk, the former leaving the machine at D

and the skimmed milk through spout E. The bowl is revolved at some 8,000 or 9,000 revolutions per minute by power, or, as in the case shown, by hand-crank F. This drives the train of gearing shown. The last member of this train is the worm-wheel H, which, contrary to the usual office of the worm-wheel, drives the steep pitch worm J. This worm is cut on the spindle of the bowl which thus receives its rapid motion.

The gears run in a bath of oil which lubricates all the teeth and all the bearings. The easy running of the machine is naturally of extreme importance. The bowl is geared up from the handle in the ratio of about 150 to 1, and with this tremendous increase a slight amount of friction will mean a great difference in the amount of work imposed on the operator. This is one of the points which necessitates very careful work in the construction of the machine. So well are the gearing and journals made and fitted that the weight of the handle will start the bowl in motion.

The bowl and spindle rest on a thrust bearing K in the base, formed of a single hardened ball between the hardened stationary and revolving thrust faces. A compressed felt cushion under the lower face supplies elasticity to prevent undue shock. The crank F drives shaft G by means of a ratchet which permits the bowl to be revolved only in one direction. If it were attempted to drive it in the other direction, there would be a tendency for the bowl to unscrew from the worm and lift out of the frame. The same tendency would be met with if the handle were rigidly fastened to the shaft and it suddenly met with an obstruction, stopping the movement of the train of gears. The ratchet prevents damage
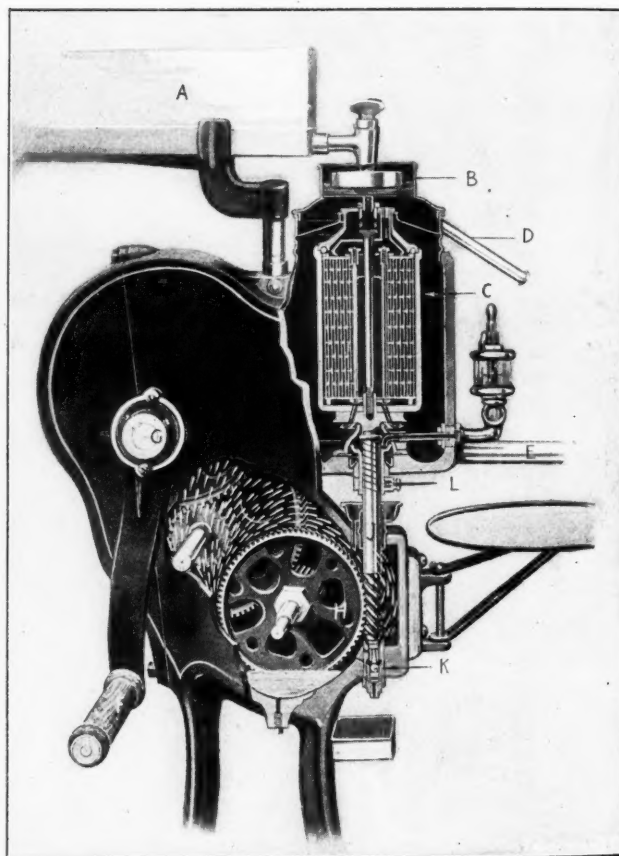
Fig. 4. Mechanism of the United States Separator

from these causes. When the machine is stopped, the bowl and its connected spindle may be easily lifted out for cleaning.

Worm-wheel H revolving in the bath of oil, lubricates all the gears and bearings of the train, as well as the worm and step-bearing. The upper neck bearing, L, of the spindle, is oiled by a sight-feed lubricator, and is held in a central position by an elastic steel washer, whose compressing effect may be increased or diminished by means of the thumb-screw shown. This adjustment of the spring washer makes provision for steadying the spindle under varying conditions of running balance.

How the Cream is Skimmed from the Milk

In the centrifugal machine the cream is separated from the milk very much faster, but in exactly the same way that it is done in a pan on the "swing-shelf" in the cellar—that is to say, the cream rises to the top because it is lighter, while the milk globules sink to the bottom because they are heavier. The sole function of the separator is to hasten this process by intensifying the force of gravity and by making it a continuous operation, automatically skimming the cream as fast as it rises to the top. The way in which it does this will be understood by reference to Fig. 5, where is shown a section

Fig. 5. The Bowl of the Separator, showing the Flow of the Skimmed Milk and Cream

through the bowl. All the parts shown revolve at a high rate of speed with the exception of the stationary nozzle M for the milk.

It was said that the separator is a machine for intensifying gravity, thus hastening the rising of the cream. In the bowl shown, which is $3\frac{3}{8}$ inches inside diameter, and revolves normally at 9,000 revolutions per minute, the centrifugal force at the outside edge would be
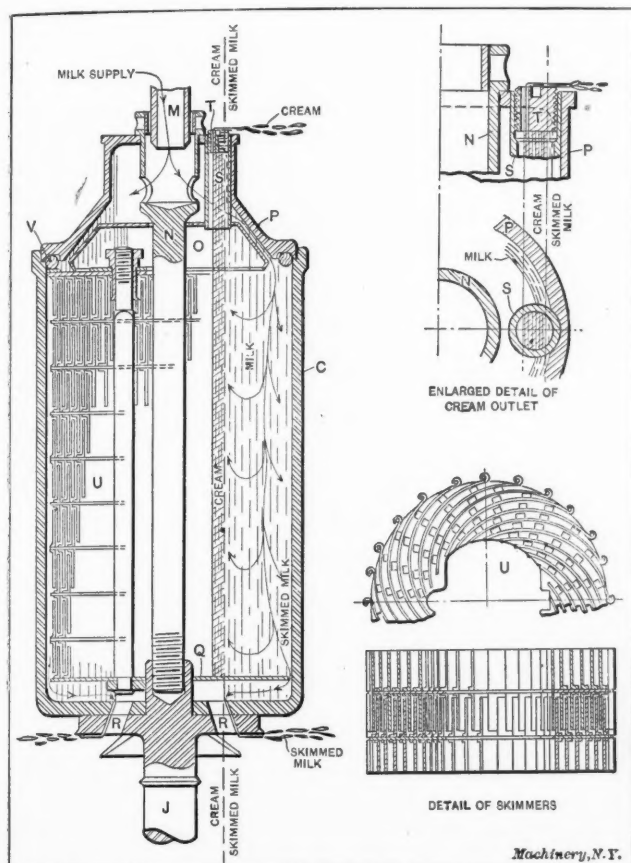
$$\frac{0.000341 \times 1^{11}/_{16} \times 9,000^2}{12} = 3,880$$

times the forces of gravity—in other words, an ounce located at this point would weigh 3,880 ounces. This result is obtained from the regular formula for centrifugal force.

Now this centrifugal force acts horizontally, and it so far surpasses the vertical force of gravity that the milk stands in a vertical wall against the side of the bowl, forming a hollow cylinder within it as shown at the right side of the bowl section in Fig. 5. A section at the left of the center line is shown with the skimmers in place. These, as will be explained, intensify the action but do not alter the principle.

In Fig. 5 the milk enters through a nozzle M, into the hollow top of the cover bolt N, and out through the side holes into the cover P. From here it passes through the narrow space between the cream chamber O and the cover into the main body of the milk within the bowl. Here, having attained the speed of the bowl, the centrifugal force begins to separate the cream globules from the milk as has been described, the former moving toward the center, and the latter settling close to the shell of the bowl as shown by the separating arrows. The skimmed milk passes downward through the bowl, and around

the outside of diaphragm Q, which evidently prevents the escape of cream, since none of the light fat globules will be found at the outlet passage, so near the periphery. From the space below the diaphragm Q, the skimmed milk finds an outlet through the drain holes R, from which it is thrown outward against the casing in which the bowl revolves, running out through tube E in Fig. 4.

It will readily be seen that the distance of holes R from the center determines the inside diameter of the hollow cylinder of milk and cream. The inside diameter above diaphragm Q is smaller than that below, owing to the fact that there is no cream in the lower space. This layer of cream, prevented from escape at the bottom, spreads over the whole inner wall of the cylinder of milk, reaching up through the cream tube S above cream chamber O. The upper end of this tube is closed by cream screw T, which has drilled through it a small eccentric hole. Through this hole the cream is thrown out against the inner wall of the cream pan and its cover, from which it is drained by the cream spout D in Fig. 4.

The purpose of the eccentric hole in the cream screw T is to control the thickness of the cream. By turning this screw the outlet hole may be brought closer to or further away from the center, draining the cream either at the inner stratum, where it is thickest, or at a larger diameter, where it begins to be more diluted with milk. A very slight change of this screw will make a great difference in the consistency of the cream. It is to be understood, of course, that the machine takes practically all the cream, in any case, but it will take as much milk with it as may be required to give the desired consistency. Too thick cream is difficult to handle and unsatisfactory to use.

This whole process of continuous separation will be understood more clearly, perhaps, if Fig. 5 is turned a quarter way round, so that its right side becomes the bottom of the
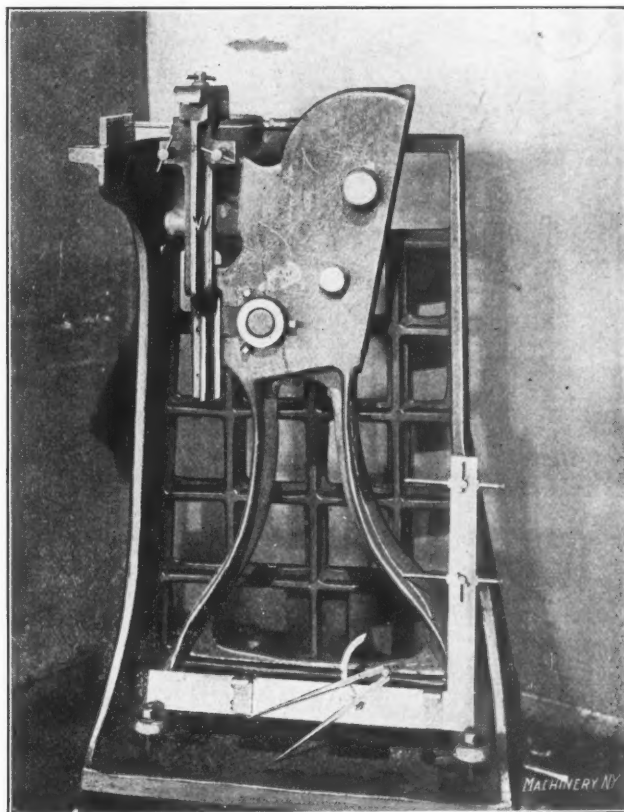
Fig. 6. Lining up the Frame in the Cradle which holds it for the Various Drilling and Finishing Operations

view. If then it be considered that the layers of cream and milk be acted on by gravity, or by a similar force many times as great, it will be seen that the milk flowing in through tube M, through the bowl and under diaphragm Q and out at R, becomes separated from its cream, the latter escaping at tube S.

Details of the Bowl Construction

The machine as just described, works very much as the earliest forms did. It is found by experiment, however, that the capacity and clean skimming qualities of the machine can

be greatly improved by filling the space between diaphragm Q and cream chamber O with a series of guides or "skimmers," U. These skimmers serve three purposes. First, they rapidly bring the cream up to the velocity of the bowl; second, they encourage an even, steady flow of milk through the machine without stagnant areas, guiding the milk outward and toward the bottom and the cream inward and toward the top; and third, they so prolong the passage of the milk that it is thoroughly subjected to the action of this separating centrifugal force, so that the cream is more thoroughly removed.

The form of skimmer used in this machine is shown in place in the bowl at the left of Fig. 5, and in detail at the right of the engraving. The whole space between O and Q is filled with these skimmers, which interlock with each other, as shown, in such a way as to double the number of milk passages, thus increasing the tortuousness of the flow and making the separating action more efficient.

A point in the construction of this bowl which should be noticed is the method of packing the joint between the cover P and the bowl C. After the skimmers U have been placed in the bowl, rubber ring V is loosely laid on the upper one

ting the work up in these cradles, so that all the holes and surfaces will machine out. For this purpose he uses various height gages, squares, scratch gages, etc., locating from the finished surfaces of the cradle, using as well the special tool W, which shows how to get the proper relation between the spindle and the worm-wheel shaft, with the proper amount of finish around the hubs. One man is thus engaged in laying out the work continuously, while other men perform the drilling operations. While this is a practice which has often been mentioned and universally commended, this is the first time that the writer ever remembers having seen it in actual use.

After thus being lined and set up in the cradle, the frame, still mounted therein, is carried through the various drill-press operations required to finish it. The first of these is the machining of the holes on the axis of the bowl and spindle. This is done on a drill press, as shown in Fig. 7, with various special cutter heads, boring bars, etc., carefully supported and strongly driven to secure proper alignment. The head shown in place on the machine is cleaning out the inside diameter of the bowl casing and finishing the edge or rim. Roughing and finishing tools, both mounted in the same head, follow each
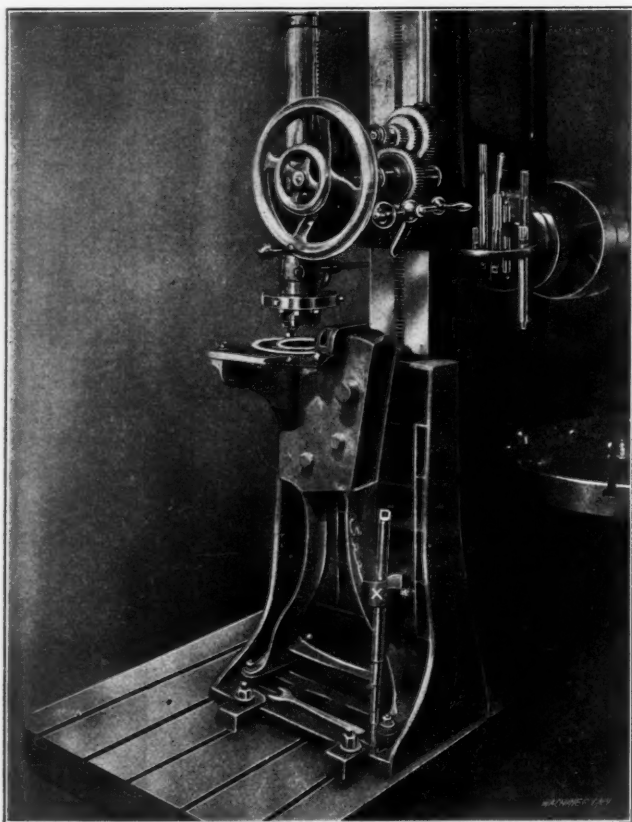

Fig. 7. Machining the Holes and Cylindrical Surfaces about the Axis of the Bowl and Spindle

Fig. 8. Drilling, Reaming and Counterboring the Bearings for the Gears

and the cover P is placed on top of this, making a metal to metal joint with C, and enclosing the ring in the groove shown. Cover bolt N is next tightly screwed in place with a spanner wrench, clamping P and C fast together. This, however, would not make a tight joint against the enormous centrifugal pressure. It remains for the rubber ring V to do this, under the influence of the centrifugal force, which, at high speed, causes the ring to hug tightly into the joint, effectively preventing the escape of milk. The higher the speed and the higher the consequent milk pressure, the more effectively will the ring make the joint, thus sealing it against the escape of milk.

Machine Work on the Frame

As intimated, a study of the manufacturing methods employed at this plant gives one a very high regard for the quality of workmanship required for making these separators. It is out of the question to describe all the operations involved, so certain of the more interesting ones have been selected as examples of the remainder of the work.

In Fig. 6 is shown a fixture used for lining up the work. Several of these fixtures (or "cradles" as they are locally called) are provided. A man is continuously engaged in set-

other in this operation. Boring bar X is provided with the necessary cutters for boring the various surfaces of this axis at one cut, thus giving assurance of their true relation to each other.

In Fig. 8, the frame, still mounted in its cradle, is shown laid on its side and having the shaft holes for the driving gears drilled, reamed and counter-bored. One of the jigs for doing this is shown dismounted from the work at F_1 in front of the cradle. This jig has a central tongue A, entering the opening in the side of the frame, and provided with a hole through which passes the arbor Y, shown in the frame being machined. This arbor, fitting in the spindle bearing holes in the frame, locates the jig, and with it all the centers of the gearing train, in proper relation with the spindle. The counter-boring bar Z, as shown, is used for facing the hubs for the gear shafts, being fed down on them for cutting on the upper side, and drawn upward with the cutter reversed for finishing on the lower side.

After these operations have been completed, together with one or two more of less importance, the frame is thoroughly inspected. The outfit for doing this is shown in Fig. 9. Mounted on the axis of the spindle bearings is shown a sensi-

tive test indicator B_1, attached to the end of arbor A_1. By revolving this arbor, the test indicator tells whether or not the spindle bearing holes are concentric with the finished surfaces at the upper end of the bowl casing. By the use of a series of multiplying levers on the same arbor, it is also possible to use the same indicator for finding out whether the lower spindle bearing holes are in line with the neck bearing at the lower end of the case.

The center distances for the gearing are also carefully tested by means of gages like that shown at C_1. This consists of a strap with a fixed plug at one end and a movable plug at the other. With the fixed plug in one hole, it should be
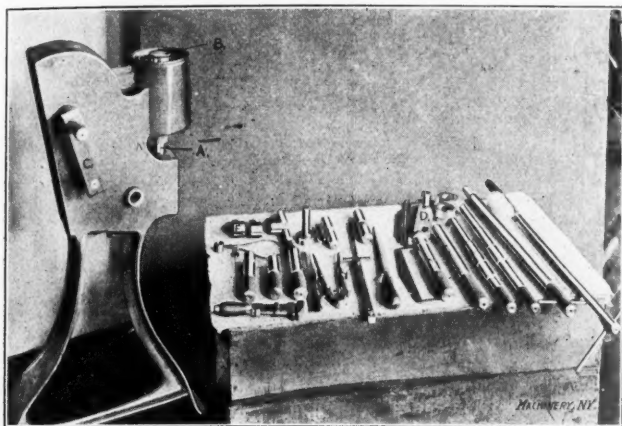

Fig. 9. Tools used by the Inspector in testing the Work done on the Frames

possible to push a standard plug through the other end of the strap into the hole in the casing, if the drilling and reaming has been done properly. This is tested on both sides of the frame, and a similar strap is provided for the second gear reduction, as shown at D_1. Various other plugs, test arbors, etc., are shown. The gage at E_1 is mounted on an arbor passing through the worm-wheel bearings. When swung up and down, it must just barely touch a corresponding arbor placed in the spindle bearings.

Machining the Spindle

The spindles of this machine are made of high carbon steel drop forgings, and are roughed out on the Potter & Johnston automatic chucking machine. It might seem at first as though this would be an impossible job, but the machine has been equipped with special tools which make the operation quite practicable. The spindle (see J, Figs. 4 and 5) is first held
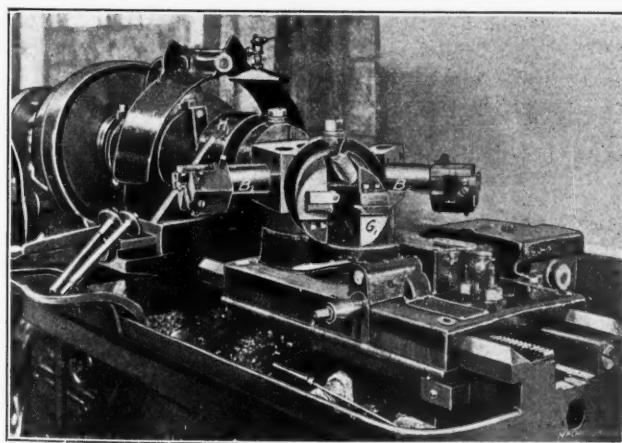

Fig. 10. Rough-turning and Centering the Spindles on the Potter & Johnston Automatic Chucking Machine

in the chuck of the machine by its stem while the flange end is machined. This is a commonplace operation for the automatic. The second operation, shown in Fig. 10, is more unusual. The finished flange of the spindle is held in the chuck with the tail of the work projecting forward. In the turret of the machine are mounted two sets of two tools each, a finished piece of work being delivered at each half revolution of the main cam drum.

The tool at work in the illustration is identical with that shown at G_1, which will perform the same operation on the next piece placed in the chuck. This is a turning tool which

commences at the chuck end of the work and feeds outward. The purpose of taking the cut in this way is to permit back resting from the beginning of the cut on the finished diameter left by the first operation, and at the same time to obtain the better results expected in feeding outward on a slender piece, as compared with what would be obtained by feeding against it.

To produce the desired result, the back-rest and cutting tool are mounted on swinging jaws in the heavy holder shown. These jaws are normally held outward by a spring so that they pass over the work freely, when being brought up to the cutting position next to the chuck. When they have arrived at this position, however, both follow rest and blade are closed in onto the work by two special cross-slides (one slide is shown at H_1) which are given the form of one-half bearings, and encircle the finished cylindrical surfaces on the outside of the jaws of the turning tools. The movement of the two cross-slides toward the center, to bring the blade down against the work, is effected by a right- and left-hand cross-slide screw operated by a modification of the regular cross-slide cam mechanism. After the shank of the spindle has thus been rough turned, the second tool, B_1, turns the small diameter at the outer end and centers it.
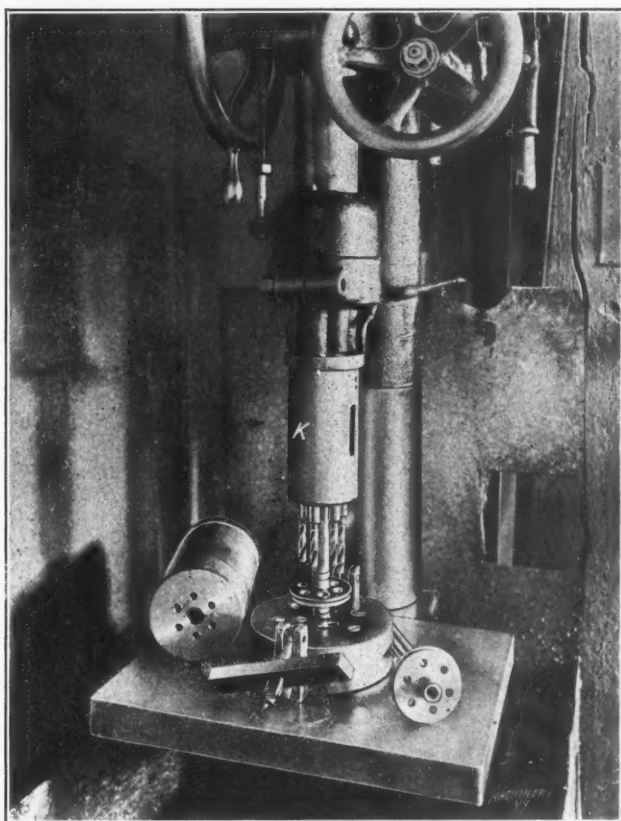
Fig. 11. Multiple Spindle Attachment for Drilling the Rivet Holes in the Spindle Flange and Bowl

The next interesting operation on the spindle is the drilling of the six holes by which it is riveted to the bowl. This is done in a drill press provided with a special multiple spindle attachment, as shown in Fig. 11. The drill spindles are operated by a crank mechanism similar to that used in other devices of this kind, permitting a strong drive at very close center distances. The center of the attachment is hollow, permitting the spindle to pass up through it as shown. The bowls are drilled with the same device, the outside diameter of body K being small enough to enter the bowl. The same attachment is used for counter-sinking the holes in both pieces.

From this point on, the operations on the spindle become merged with those on the bowl, as will be described.

Machining Operations on the Bowl

Cream separator bowls have to be made of first-class material. A four-inch bowl running at 11,000 revolutions per minute (a peripheral speed of two miles per minute) is subject to a very high strain, and when it is considered that there is always a possibility of some husky dare-devil hired man getting hold of the crank and turning it about twice as

fast as it ought to be turned, it will be seen that provision has to be made for emergencies.

The bowls are therefore made from cold or hot-drawn seamless blanks of high carbon steel, and before sending them out in the machines, they are tested at a speed nearly double that at which they will run normally. This means that the centrifugal strain will be four times as great as the normal, since this increases with the square of the velocity.

The cup blanks of the bowls first have a hole drilled in the center of the bottom by means of a simple jig which centers itself accurately. This hole is the one into which the plug end of the spindle projects, as shown in Fig. 5. It is drilled
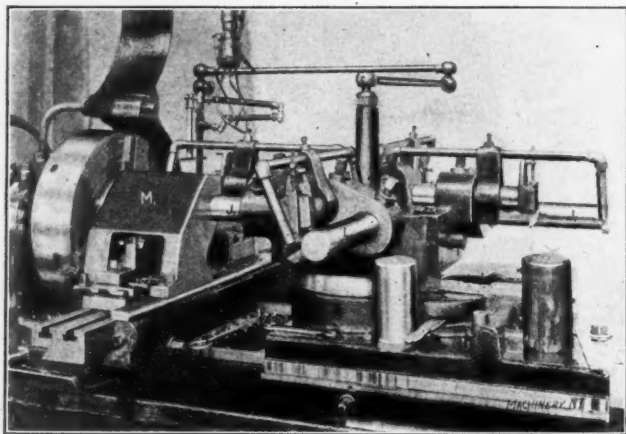

Fig. 12. Turning and Facing the Outside of the Bowl with Supported Tool-holders of Special Construction

first, in order that it may serve to locate and steady the outer end of the blank in the outside rough turning shown in Fig. 12.

This is another Potter & Johnston automatic operation, and is performed with an interesting outfit of tools. The work, of which a rough and a turned sample are shown on the turret slide, is held in a special chuck which grips it on the inside of the rim, while the outer or closed end is steadied by a projecting plug on the end of a pilot solid with the chuck. This leaves the whole of the exterior surface of the bowl free to be turned, without interference with the chuck jaws or other holding devices.

On this machine, as in Fig. 10, two sets of tools are mounted in the turret, so that the machine completes two pieces of work at each revolution of the cam drum. The first operation is the rough turning and facing of the blank. In the
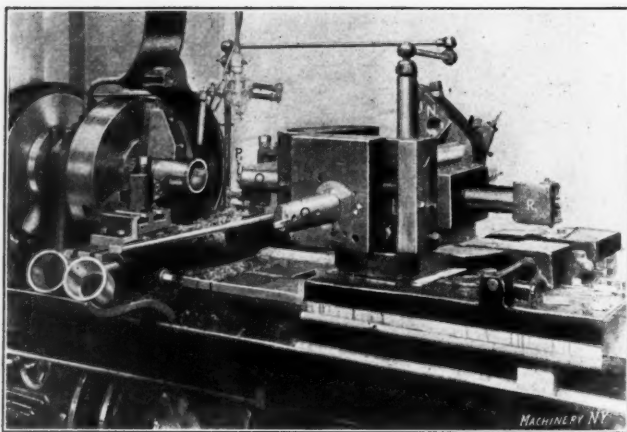

Fig. 13. Boring and Facing the Bottom of the Bowl with Turret Tools manipulated by the Cross-slide

second operation the blank is finish turned and the corner is rounded. The unusual feature of the tool equipment is the provision made for steadying the outside turning tools. These are mounted in long overhanging bars J_1 and L_1, as shown. To give the maximum of stiffness with this long overhang, a bearing M_1 for these tool-bars is immovably bolted to the cross-slide bed. This bearing is bored out to form a seat for the bars and in this seat they are supported during the cut, so that the turret is under no strain except that for feeding the tool ahead. There is no deflection in the turret mechanism of a kind that will limit the rate of feed, or impair the

accuracy of the cuts. Oiling arrangements are provided, as shown, to bring a stream to the point of each tool when it comes into operation.

The next automatic operation on the bowl, that of finishing the bore, is shown in Fig. 13. Here also a special tool equipment is provided. The bowl is held by its outside diameter in soft jaws, turned in place, so that the first and second operations run true with each other. An oil pipe passes through the hollow spindle and discharges oil through the hole drilled in the bottom of the bowl, so that the flow outward clears away the chips as fast as they are made in the boring operations. A valve at the nozzle of this oil pipe opens automatically when a piece of work is pressed into the chuck, and closes again when it is removed.

The first cut taken in this operation is that of rough boring and rough turning the end, which is performed by the standard combination tool N_1 at the back side of the turret in the engraving. The second operation is that which is shown about to commence, and consists in rough facing the inside of the bottom. The projecting tool-holder O_1 for this operation is mounted in a cross-slide on the face of the turret, and is normally pressed back by a stout coiled spring. The turret is fed up until the blade has reached the proper depth, when the rear cross-slide comes up, carrying a roller abutment P_1 which feeds the turret cross-slide tool forward on its sliding base, facing the bottom of the cut from the center in toward the side.

The third tool Q_1 and its cut are like the second, being first a finish facing operation performed in the same identical
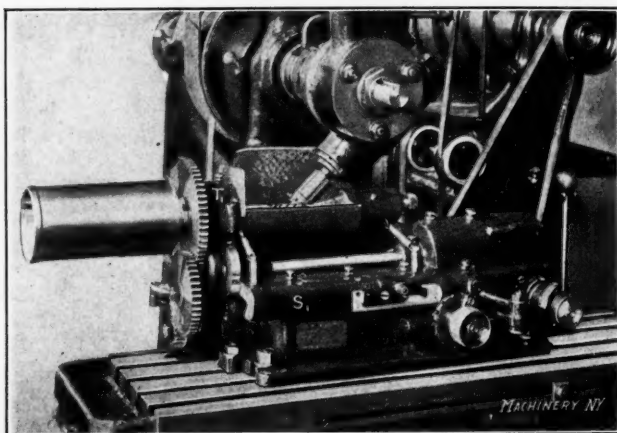

Fig. 14. Milling the Spindle Driving Worm in a Completely Automatic Attachment for the Plain Milling Machine

way. At the end of this operation, however, the cross-slide abutment remains stationary, while the turret is fed backward with the back side of the tool bar held up to its work by the roller on the abutment. By this means the same blade is made to face the bottom of the hole and finish the bore.

The fourth and last cut is taken with the inserted blade reaming or counterboring tool R_1, which finishes the outer edge of the bowl very accurately to size. After this operation the bowl is drilled in the attachment shown in Fig. 11, and the bowl and spindle are riveted together.

Reasons for the Use of Automatic Machines

It struck the writer that the tool equipment illustrated in Figs. 10, 12 and 13, together with others of a similar nature not here described, make up the most ingenious and highly developed equipment he has ever seen used on an automatic turret machine. All of those illustrated, it will be seen, adapt the machine for taking long cuts with rapidity and precision, thus bringing it more closely into competition than usual with the engine lathe and with certain forms of highly specialized hand-operated lathes for the same work. This brings up the question of the field of the automatic machine—a question which is never ending, because of the ever-changing conditions under which it is decided in different shops.

A natural thought in looking at Figs. 10, 12 and 13 is that the tool designer has taken considerable pains to adapt these automatic machines to work for which they are not usually employed. But that this process of adaptation has been well done, there can be little doubt to any one who watches these

machines at work. They require very little attention, and produce work up to the high standard required of them.

Various other advantages are urged for this type. That of low labor cost is taken for granted in successful automatic machinery. Besides this, a less expensive grade of labor may be employed, and men may be more easily changed from one job to another. On hand-operated machines working at a high efficiency, there is a tendency for the workman to specialize, and his production, when he is broken in on a new job, suffers more than does that of the automatic machine and its operator under the same conditions. The use of the automatic thus gives a greater flexibility to the organization.

One experienced man is employed to look after the tooling and setting up of the twenty odd turret machines used here. By giving proper care to the cutting edges, the automatic machines under his control can be depended on to produce work of a high degree of uniformity in dimensions, hour after hour, and day after day. Neither he nor the men under him are rushed in getting out the maximum production of the machines—the duties of the operatives being, ordinarily, simply that of putting in and taking out the work.
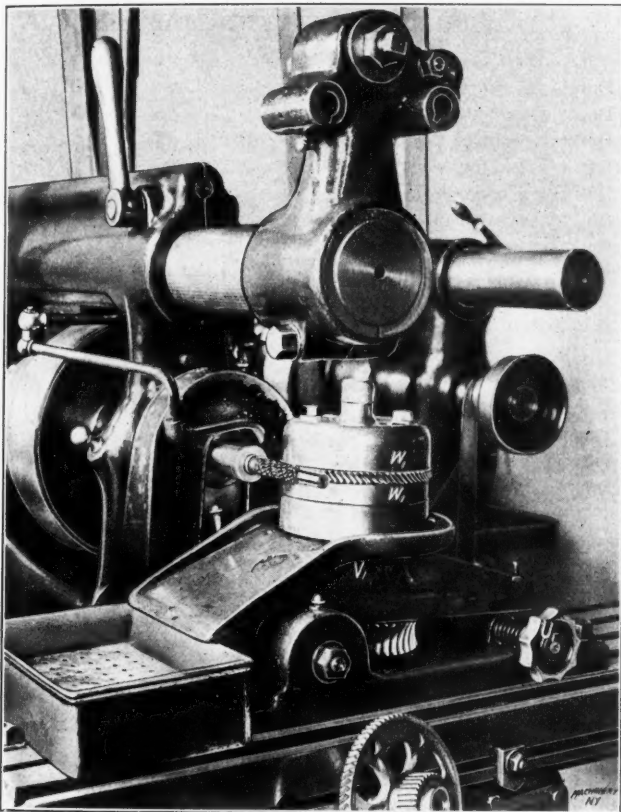

Fig. 15. Hobbing Attachment for Cutting the Teeth in the Driving Worm-wheels; Overhanging Arm turned back to show Hob

Against these advantages must be weighed the advantages of hand machines in other respects, such, for instance, as the lower capital investment, the (sometimes) higher output per machine, the more constant personal supervision, and the less elaboration required in the tool equipment. In striking the balance between these advantages and disadvantages, the management of this shop feels that it has reached the right conclusion for conditions as they occur in the work here.

Finishing Operations on the Bowl and Spindle

After being assembled, the bowl and spindle are finish turned on the outside over the whole length in the engine lathe, the work being held on an internal expanding chuck, which accurately centers and holds the bowl by its interior surface. This gives assurance that the outside of the bowl and the whole length of the spindle will be turned true with the inside of the bowl. The neck bearing, next to the flange of the spindle, is, in this operation, turned and filed to its finished size, which is required to be accurate within 0.0002 inch. Stock is left for grinding at the lower or step bearing end of the spindle. The reason for finishing the neck bearing at this time will be understood in connection with the operation shown later in Fig. 16.

The bowl and spindle being thus finish turned all over, the work is next taken to the milling machine department to have the worm thread cut on the spindle. This is done in the special Brown & Sharpe milling attachment shown in Fig. 14. This attachment is entirely automatic. The main table of the milling machine is locked in position at the proper point to center the cutter with the work and set it to proper depth. The work is mounted on a supplementary slide S_1 in the fix-
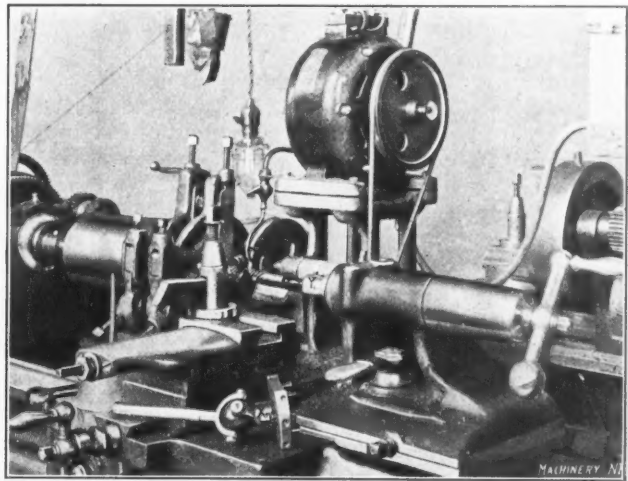

Fig. 16. Finish Turning and Grinding the Bowl Spindles

ture, whose feed-screw is geared (to give the desired lead of helix) with the quill chuck, which grasps the spindle by the neck bearing.

Properly set up in this way, the mechanism of the device feeds the spindle forward, cutting one thread. When this thread has been cut the proper length, an automatic stop throws in operation mechanism which first rocks the spindle, carrying head T_1 back away from the cutter, returning the slide to its initial position, then indexes the spindle for the cutting of the second thread, and lastly sinks the cutter in to depth again. Besides this, the device is "full automatic" to the extent that its feed movements are arrested when the required number of threads have been cut. The mechanism is connected to the regular telescoping feed shaft of the miller. The cutter is mounted on the regular vertical and angular milling attachment, set to agree with the desired helix angle of the thread.
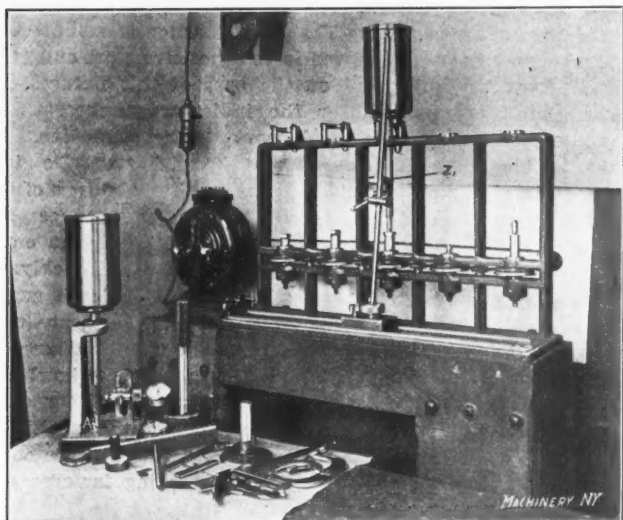
Fig. 17. Testing Outfit for Inspecting the Bowls and Spindles

The corresponding operation for hobbing the worm-wheel may be mentioned here though it is a little out of the strict order of operations we have been following. In this attachment (see Fig. 15) the worm-wheel is mounted on a vertical work-spindle on a special fixture in the milling machine, the table of which has been clamped in the desired position as in the previous case. This work-spindle is driven by worm-gearing and a train of spur-gearing connecting it with the spindle in the proper ratio.

The feeding of the hob in to depth is done by hand through the operation of knob U_1 shown at the base of the machine.

This, through suitable connections, rocks the work-spindle base V_1 about the axis of the work-driving worm, thus moving the work in toward or away from the hob as may be desired. The work is only located by the work-spindle, being held by special face-plate clamps W_1, which clasp the rim firmly, close to the cutting point. This prevents the distortion which would otherwise be inevitable in so small and light a worm-wheel.

In Fig. 16 is shown a lathe rigged up for the finishing operation on the worm-spindle. The work is held in two back-rests, one of which bears on the neck bearing, which was filed to size in the finish turning operation before described; the other back-rest bears on the spindle just above the worm bearing. As these surfaces were finish turned "in the air," while the bowl was held accurately by its interior bore, every assurance is given that the bowl is so held as to run true; and as the spindle was chucked by these same surfaces in the worm cutting operation, it may be assumed also that this will run true. The bowl is driven from the spindle of the lathe by a universal joint driver X_1, which is shown lying on the top of the carriage in Fig. 16. The four pins in its face bear on the bottom of the bowl and take the thrust of the cutting. The copper friction pieces at the sides are expanded by the taper screw shown so as to grip the sides of the bowl and drive it firmly without distorting it.

The lathe is provided with a turning tool for taking finishing cuts over the step-bearing, and with a motor-driven grinding attachment, as shown, for finish grinding the step-bearing. A suitable tail-stock holder is furnished for carrying drills, bits, etc., for finishing the hole in which the hardened step is inserted. This, with various minor operations, completes the work on the bowl and spindle.

Inspecting and Balancing the Bowls

The outfit shown in Fig. 17 is used by the inspector for testing the work on the bowl and spindle. The frame shown at the back contains a series of motor-driven spindles, each provided with a true running socket for receiving various designs of separator spindles and bowls. One of these is shown in place. The dial test indicator Z_1 is mounted on an adjustable swiveling and sliding post, so that the truth of any or all of the revolving surfaces, from one end to the other, may be tested by it.

The fixture shown at A_2 is for testing the truth of the worm cutting. The spindle is inserted in bushings in the fixture, which bear on the journals on which the spindle is to revolve in the completed machine. The dial indicator is mounted on a plunger which may be moved in to a positive stop, and is in turn carried by a standard on the base of this fixture. A forked point is provided for the indicator plunger, which straddles the worm thread and bears on the pitch line. By bringing this plunger over each worm thread in turn, the pitch radius at each thread is indicated; the truth of the tops of the threads is a matter of comparatively little importance; the question is, "Do the acting surfaces of the threads run out?" That question the indicator solves accurately and quickly.

The various other tools shown, consisting of depth gages, internal and external micrometers, snap gages, etc., are used in obvious ways to test the accuracy of the various diameters and lengths of the work. All this accuracy in the bowl and spindle is required to produce the proper balance for quiet running at high speeds. The more accurately the machining operations are performed, the less time will have to be spent on the costly and tedious work of compensating for errors in balance.

The balancing of the bowls is done with all the rotating parts assembled and (in this firm's practice) with the bowl full of liquid. This latter is an important improvement in this operation, as the distribution of weights in the bowl must inevitably be somewhat different when it is full from what it is when empty. It makes the balancing operating more costly but better results are obtained.

This job of balancing separator bowls is a peculiar one, being a trade in itself. So far as we know but one article descriptive of it has ever been written, and that was published in MACHINERY.* It is said that the men have to learn the

* See "Cream Separator Bowl Balancing" in the September, 1907, issue of MACHINERY.

business for themselves, it being almost impossible to teach it, and that different men work in different ways. Some men cannot learn to do it at all. What is reputed to be a fair statement of the case was made by a German in this shop, who tried for six months to get on to the job and finally failed. "First, I put in some solder on the top and then on the bottom, and then I put in some more, and then I fill her up with solder, and then I take it all out, and she run better than she did before." All of which is rather discouraging for the editor, who likes to set things down definitely in black and white.

This concludes the list of operations selected for this article, to show the character of work required and obtained in the building of cream separators. On hearing the name "Vermont Farm Machine Co.," a vision naturally arises in the mechanic's mind of a blacksmith shop sort of an establishment, where plows, shovels, harrows, cultivators and other tools of that kind are made. It is to be hoped that this article will dispel this illusion, and that the name will henceforth stand in the reader's mind for machine shop work of a very high grade indeed.

* * *

DON'TS FOR PATTERN-MAKERS

H. E. WOOD*

Don't use watery glue.

Don't glue battens on a pattern.

Don't be afraid to ask for information.

Don't set a plane flat down on your bench.

Don't try to glue up a piece of wet lumber.

Don't forget to put draft on your patterns.

Don't use green or wet lumber; it is no good.

Don't forget to make allowance for your finish.

Don't try to trim work without a very keen-edge tool.

Don't nail a standard pattern unless absolutely unavoidable.

Don't forget to mark your loose pieces with the pattern number.

Don't sandpaper your work until you are all through with trimming.

Don't start to build a pattern before you understand the drawing.

Don't put on more than one coat of shellac without sandpapering it.

Don't forget to study other men's work, and profit by their experience.

Don't be in too much of a rush when you are working on a complicated job.

Don't put any unnecessary work on a pattern that is to be used only once.

Don't waste leather fillets in places where wooden ones can be used just as well.

Don't hold a hand lathe tool at right angles to the center line of a revolving piece.

Don't try to scrape a piece of work in a lathe, but hold the chisel so as to cut it.

Don't try to drive a nail through a piece of hardwood without first boring a pilot hole.

Don't make a pattern to suit your own liking, but remember that it goes to the foundry.

Don't make a coreprint so that it is impossible for the molder to get it out of the sand.

Don't put a leather fillet around a small curve without wetting it in luke-warm water.

* * *

An iron and steel scrap heap of enormous dimensions was shown in an illustration in a recent issue of the *Iron Trade Review.* The scrap heap is one of the relics of the great conflagration in San Francisco in April, 1906, the principal accumulations being those in the yards of the Great Western Iron and Steel Co., where four scrap heaps 100 feet square and 40 feet high were recently stored. All the scrap was cut in equal lengths of 18 inches and piled in one solid mass, with the sides practically as smooth and solid as a brick wall. Only one scrap heap now remains, the other three having been drawn upon as the material was needed for the furnaces.

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DIE-BEDS OR BOLSTERS FOR PRESSES

DORBRO

The subject of die-beds or bolsters is one of considerable importance, and is deserving of greater attention than it often receives in the shop or designing room. It has been the experience of the writer that many of the troubles encountered in the use of press tools are due to this feature being badly designed or poorly constructed. Many a fine die has been ruined because it has not been properly secured in
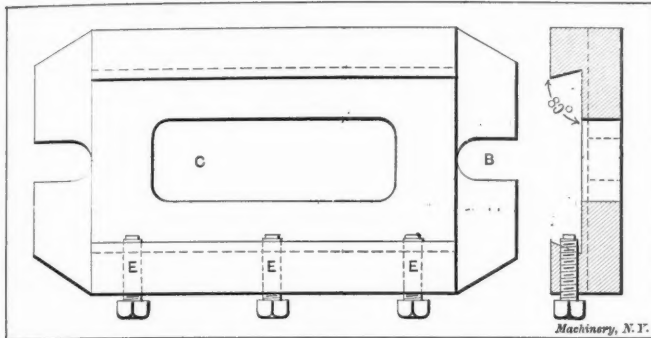

Fig. 1. Die-bed of the Style commonly used in Jobbing Shops

the die-bed and consequently has shifted while in operation; or because the holes in the die-bed through which the blanks or punchings are supposed to pass have not been made large enough to allow them to pass through freely. As a consequence the blanks get jammed in the die-bed and pile up into the die itself and are compressed by the pounding of the punch, until the punch or die breaks from the strain. The principal functions of a die-bed are: first, that of supplying an adequate support for the die, and a holder to hold the die in its proper position to be engaged by the punch; and, second, to furnish a means of attachment to the press. Two of these principal points to be considered therefore in the design and construction of a die-bed are first, the method of securing the die, and second, the method of securing the die-bed to the press. Due consideration, of course, should also be given to proportion and strength.
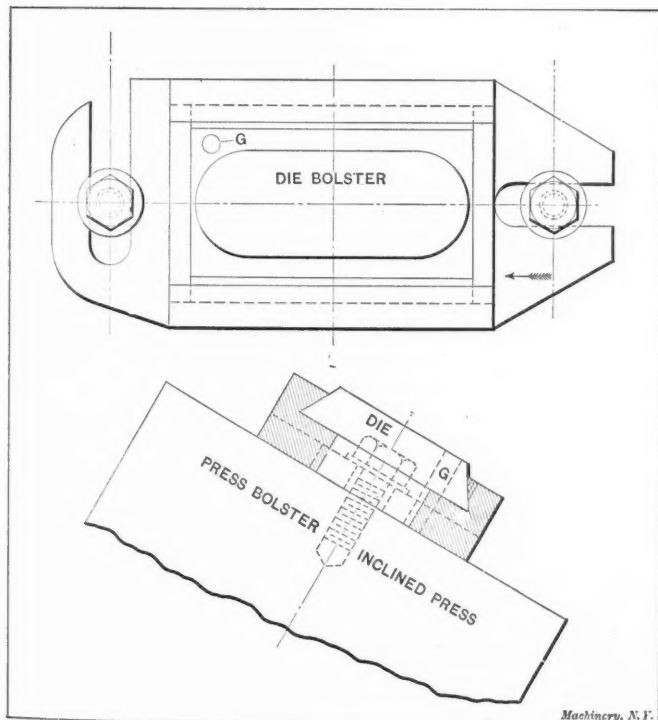

Fig. 2. Die-bed adapted to Inclined Presses

In Fig. 1 we have an illustration of a die-bed of the type generally found in the jobbing shop. The dovetail method of holding the die, with set-screws E to lock it in proper position, is employed. It is fitted with a flange J on each end with slots B to receive the clamping bolts which pass through them into the press bolster. In the center is a rectangular cored hole to let the punchings pass through. This style of die-bed

is cheap and convenient for use where several dies are to be used in one die-bed. The dies can be easily slid into place and fastened by means of the set-screws, and are easily removed when another die is to be used. This bed has the following disadvantages: first, that of being held by set-screws which have always a tendency to jar loose in punch press work, and second, the cored hole C being necessarily made large to accommodate various shapes of blanks weakens the bed and gives less support to each of the dies. It is always better, if possible, to have a separate die-bed for each die.

In Fig. 2 we have a bed for use on an inclined press. In this bolster the dovetail method of holding the die is used, but without the use of set-screws. The dovetailed opening to receive the die is slightly tapered and the die is driven into place with a copper mallet, and is then made doubly secure by the insertion of a dowel which is driven through the die into the die-bed. The dowel is shown at G. The method of clamping this bed to the press bolster is different from that shown in Fig. 1 in that the bolt slot in one flange runs at right angles to that in the opposite flange. By having the slots in this position the die-bed may be attached or removed without the necessity of taking out the bolts, thus not only saving a great deal of time and trouble in setting the tools but
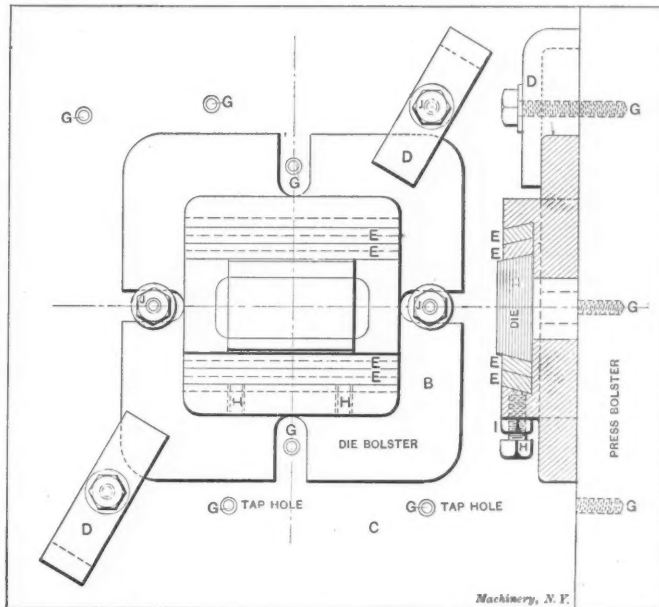

Fig. 3. Improved Form of Die-bed for General Utility

also preventing the bolt holes from getting filled with scrap or dirt and the bolts from getting lost. This is an excellent die-bed for blanking and piercing work.

An improved type of die-bed for general utility is shown in Fig. 3. In this bed the dovetail method of holding the die is used. In the illustration it will be noticed that there are four parallel pieces or gibs E placed along the sides of the die. The object of this is to provide for dies of various sizes. When a larger die is to be used one or more of these gibs may be taken out. This bolster, in addition to four bolt slots, has a flange B all around it so that it may be clamped in any position. The set-screws H which hold the die in place should be provided with a lock-nut as shown at I to lessen the chances of jarring loose. The great advantage of having a flange all around the bolster will be apparent when it becomes necessary to swing the die-bed around enough to bring the bolt slots out of line with the tap holes in the press bolster. In a case of this kind the die-bed with a flange all around it may be clamped by means of clamps as shown at D, using the tap holes G located at different places in the press bolster C.

In Fig. 4 we have another die-bed of the dovetail and side set-screw variety, but with the additional feature of end-thrust set-screws. This end-thrust arrangement is an original and novel feature. In order to obtain this additional means of holding the die securely, two square grooves B are cut in each end of the die-bed at right angles to the opening for the die. Into these grooves a plate C is fitted in which is a set-screw in such position as to come in contact with the end of the die. With one of these plates at each end, and the set-

screws screwed tightly against the ends of the die, there is less likelihood of its shifting while in operation. When short dies for simple blanking or piercing are used the end-thrust plates may be used in the inner grooves as shown in Fig. 4, and if it be desired to use a long die such as is used for progressive work where there is one or more piercing operations before the work reaches the blanking punch, the plates with the set-screws may be placed in the grooves further from the center, and thus allow for the increased length of die. When the set-screws are used in these outer grooves, the heads of the screws will come directly over the slots in the flanges where the clamping bolts should be placed; for this reason the bed should be provided with two extra slotted flanges, as shown in the illustration, to be used when necessary.

In Fig. 5 we have an illustration of a die-bed for sectional forming or blanking dies or for split dies. This bed is provided with a square receptacle to receive the dies, and with two set-screws on each side to hold the dies in place. The square forming die shown is made in four sections B which are held tightly against each other by means of the set-screws C, and are held from lifting up by screws through the bot-
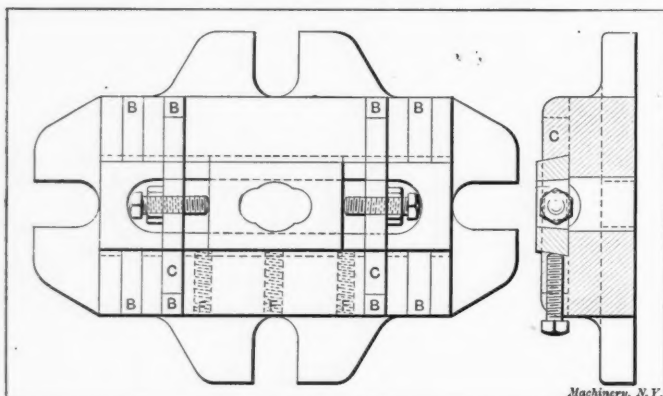

Fig. 4. Die-bed of the Dovetailed and Side Set-screw Type, also secured by End-thrust Set-screws

tom of the die-bed—one in each section of the die. The square recess is cast in the bed so that in preparing the bed for use it is only necessary to plane off the bottom and top of the flanges and mill the bottom of the recess, and drill and tap for the set-screws. The sides of the recess need not be machined as the dies have no bearing on them.

A very simple type of die-bed for bending and forming dies is shown in Fig. 6. It is simply a vise similar in some respects to a milling vise, but having two set-screws to take the place of the movable jaw. The die is simply set in the bed and clamped against the solid jaw by means of the set-screws. This type of bolster is intended for use only on dies that do not require a "push up," but where the bending or forming operations are done on a solid surface. In order to
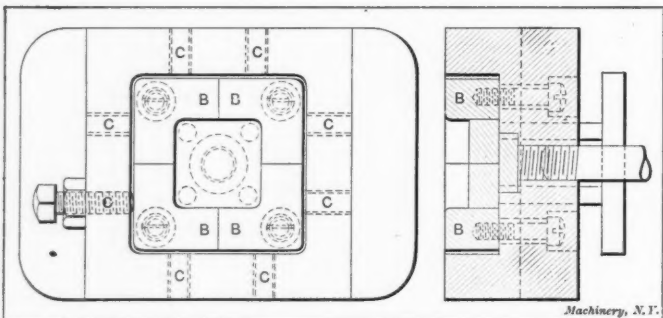

Fig. 5. Die-bed for Sectional Forming or Split Dies

obtain the best results from this die-bed, the complete outfit of punch holder, punch and die of the type shown in the sketch should be used. The punch holder and punch are made just the same as the die and die-bed. They are kept in alignment when in operation by the two guide pins E which are secured in the punch and which enter the die at every stroke of the press, making it practically impossible for the tools to shift while in operation. If it be desired to change the tools it is not necessary to disturb the punch holder or die-bed. They may be left in the press, and by simply loosen-

ing the set-screws in the die-bed and punch holder, the punch and die held together by the guide pins may be taken out and set aside and another set slipped into their places. There is an infinite variety of light bending and forming operations that can be done advantageously and cheaply with this outfit.

Fig. 7 represents a bolster for combination dies for round drawing work. This bolster requires but little explanation. It is circular in shape with two steps or extensions, two bolt
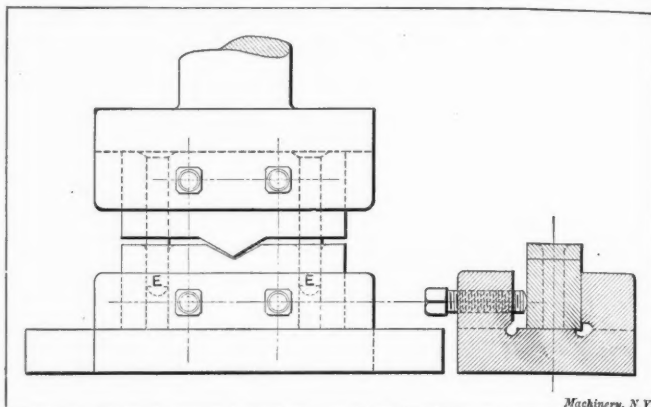

Fig. 6. Simple Form of Die Holder adapted to Bending Die

slots and a flange all around it to allow it to be clamped at any convenient place. When the combination dies are turned in the lathe the bottom die is counterbored to be a driving fit on the extension G, and is held down by screws that pass through the bed at E into the die.

* * *

STORAGE AREA RESTRICTION PLAN FOR MACHINE SHOPS

In shops where a large volume of heavy work is turned out on a comparatively limited floor space, there is a constant tendency to store work (rough, finished, and in course of machining) in areas which encroach on the passageways re-
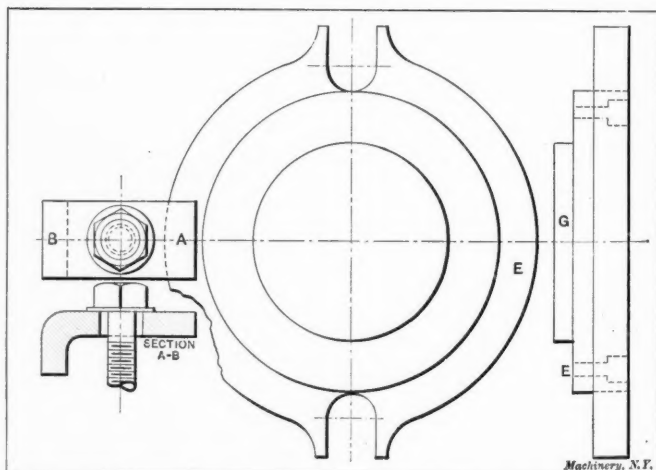
Fig. 7. Die-bed or Bolster for Round Drawn Work

quired for the movement of the parts through the shop. In the works of the Westinghouse Machine Co., at East Pittsburg, Pa., this tendency is restrained in a very simple way. The areas available for storage are marked off on the floor with lines of white paint. These areas provide for grouping work around each machine, and for using all available vacant spaces as well; but they are carefully laid out to avoid checking the freedom of movement of work and workmen. A single glance of the eye reveals any infraction of the regulations, as the lines are kept freshly painted. By this means the management has avoided that state of chronic congestion which is so fatal to economical production.

* * *

Following the example of the English Patents Act of 1907, the Australian Commonwealth has passed an amendment to the Australian patent act, which makes the manufacture of all articles patented in the Commonwealth compulsory under penalty of forfeiture of rights.

A FORMED TOOL PROBLEM

H. V. PURMAN[*]

One day the man who was making the formed tools came to me and said: "I want to make this master-tool with an angle of 15 degrees from the center line and with a clearance on the front of 25 degrees; and in addition to that I want to give it a side clearance of 2 degrees to keep it from dragging. I will set it in the planer vise tipped forward at an angle of 25 degrees and swing the vise around 2 degrees.

Fig. 1

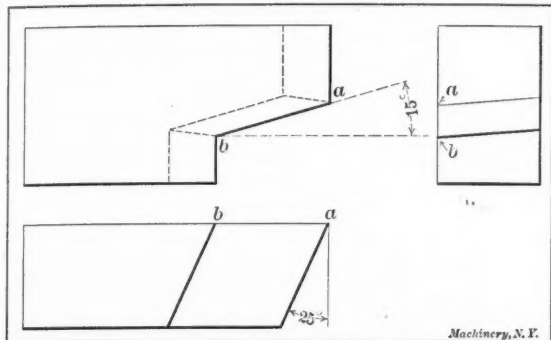Then to what angle must I set over my planer head to plane the tool so that it will measure 15 degrees on the cutting face?"

This is a sensible, practical question, but how many of our technical school men, either in or just out of college, could answer it? In the following is given a solution of this problem, worked out by the writer.

The master-tool is shown in three views in Fig. 1, where the plan, or face view, shows the side angle, 15 degrees, and the side elevation shows the front clearance of 25 degrees. In Fig. 2 the tool is shown as set in the planer vise ready

view shows the piece as seen from the side of the platen, looking squarely across, and the face view shows it as looked at in line with the platen travel, when the surface in which the points a, d, c and b are located appears as a line. This line is at the real angle of the tool-head from the vertical, and its angle with the vertical must be found.

To do this we will use a series of diagrams, representing the essential lines of the tool in various positions. Fig. 3 shows the plan of the tool, Fig. 4 its side elevation, and Fig. 5 the top of the tool in the horizontal plane when the tool is tipped forward. Fig. 6 shows the face of the tool
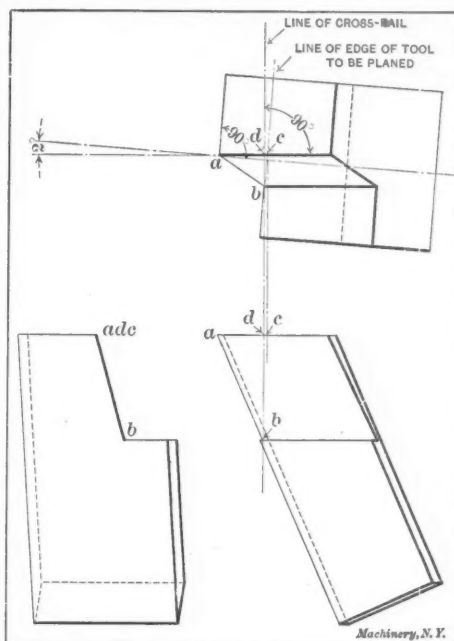
Fig. 2

merely inclined but not swiveled; Fig. 7 shows a portion of the edge receding from the corner, when swiveled, and Fig. 8 shows a line in the surface of the oblique side of the tool, each of these last two diagrams showing also the lines needed to calculate the angles and distances involved. Figs. 9 and 10
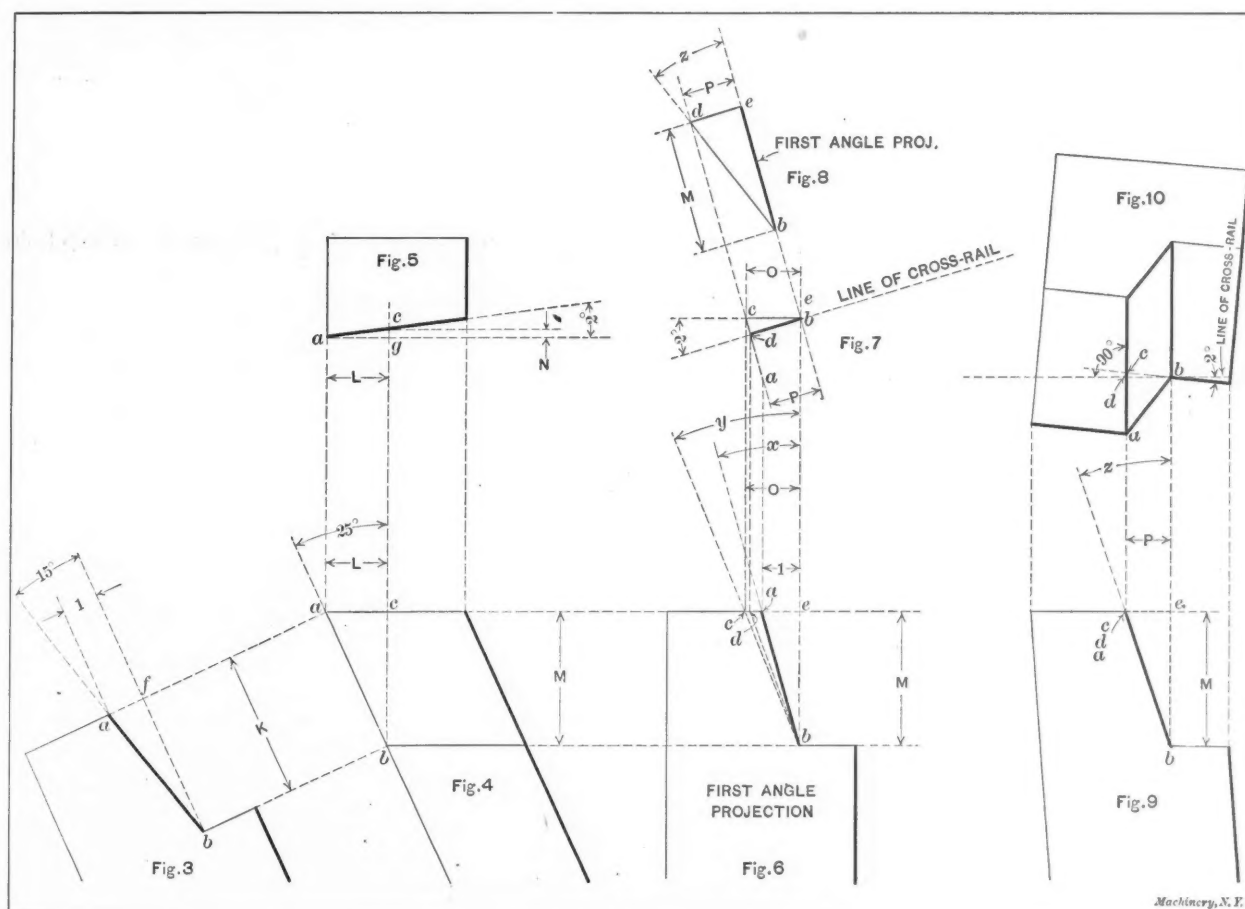
Figs. 3 to 10

for planing. In the top view the 2-degree angle is clearly shown, exaggerated, the vise and pieces being swiveled around as indicated by the divergence of the edge of the tool to be made from the line of the cross-rail. The side

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represent the surfaces, front and top, of the tool inclined and swiveled, as in Fig. 2.

Referring again to Fig. 2, it must be noted that point c is in the vertical plane containing point b and the edge terminating in b, while point d is in the vertical plane contain-

ing point b and parallel with the cross-rail, while a, d and c are all in the edge of the tool receding from a, hence in a straight line, as clearly shown in the side elevation; they therefore appear as a single point adc in the front elevation. Now ab is the cutting edge of the tool, and db is the line of feed of the planer tool, since the work is swiveled.

Throughout the views and diagrams the same points are designated by the same letters, but in the diagrams additional letters (capitals) are used to denote dimensions, for ease in calculation, and for clearness and accuracy, since the points appear in projection at different distances in different views.

Let the distance af, Fig. 3, or the actual amount the edge of the tool slants to the left, or the short side of the 15-degree triangle, be considered as unity, for simplicity, then

$$\frac{K}{1} = \cot 15°, \text{ or } K = \cot 15°,$$

$$L = K \sin 25° = \cot 15° \sin 25°,$$
$$M = K \cos 25° = \cot 15° \cos 25°,$$

and $\dfrac{M}{1} = \cot x$, or $M = \cot x$.

Angle x is the apparent or projected angle of the edge, or the angle of tool travel were the shoe not swiveled; but because of the swiveling, the tool travels over farther in rising a given height, that is, takes off more metal, and gives more clearance, and we must find what this added distance is. It is the distance cg, Fig. 5, equal to ca, Fig. 6, where g is the point directly behind a and on the line ce.

Let $cg = N$, then

$$\frac{N}{L} = \tan 2°; \quad N = L \tan 2° = \cot 15° \sin 25° \tan 2°.$$

Now O ($= ce$, Fig. 6) $= 1 + N$, and $\dfrac{O}{M} = \tan y$.

Angle y is the apparent or projected angle of tool travel when the 2 deg. clearance is given, and we look squarely at the face of the tool. But this is not the actual angle, which must be seen in the line of platen travel, as in Figs. 2, 8 and 9. The actual side motion, then, of the tool, in rising a vertical height eb or M, is $de = P$, Figs. 7, 8 and 9.

$$\frac{P}{O} = \cos 2°; \quad P = O \cos 2° = (1 + N) \cos 2°$$

$$= (1 + \cot 15° \sin 25° \tan 2°) \cos 2°.$$

In Fig. 8, $\dfrac{P}{M} = \tan z$. This triangle appears in Fig. 9 also,

and angle z is the actual angle sought. Then

$$\tan z = \frac{P}{M} = \frac{(1 + \cot 15° \sin 25° \tan 2°) \cos 2°}{\cot 15° \cos 25°}$$

[The formula above can be generalized and somewhat modified as follows: If w = angle on face of tool (here 15°),
v = clearance angle in front (here 25°),
y = side clearance angle (here 2°),

then $\tan z = \dfrac{(1 + \cot w \sin v \tan y) \cos y}{\cot w \cos v}$.

But $\tan y = \dfrac{\sin y}{\cos y}$; substituting this in the formula and reducing, we have

$$\tan z = \frac{\cos y + \cot w \sin v \sin y}{\cot w \cos v}.$$

It will be seen that this formula is identical with the one given for planing Acme thread tools in the May, 1905, issue of MACHINERY.—EDITOR.]

By substituting the values for the angular functions in the formula above, we find $\tan z = 0.31174$, which gives us $z = 17$ deg. 19 min., nearly.

The result found can best be used by grinding an angular cutter to this angle as accurately as needed, gaging with a vernier bevel protractor, stoning it, and scraping the master tool with it. This was done, and the angle obtained was so close to 15 degrees that the closest inspection with the magnifying glass failed to show any error in the tool.

CONTINUOUS PERFORMANCE PHONOGRAPH

Thorns grow with roses—evil may come out of good. It is not quite unknown that even the humble and industrious phonograph can be diverted from its peaceful pursuit and used, alas! as an instrument of torture. Many defenseless neighbors have been serenaded by conscienceless individuals with ragtime, classical and religious selections until their nerves and tempers were badly "frazzled." The drawback to the use of the phonograph for such unneighborly acts is the constant attention required of the tormentor to change the records, wind the machine and set it in motion. His own endurance may flag after hours of performance and, perforce, he will seek his bed in sheer weariness of evil-doing without, it may be, having reduced his enemies to a state of complete physical, mental and moral collapse. What is needed for this sort of warfare is a "continuous performance" machine, driven by a motor, that can be started on a choice selection of the "gold molded" and left in the solitude of its chamber, the
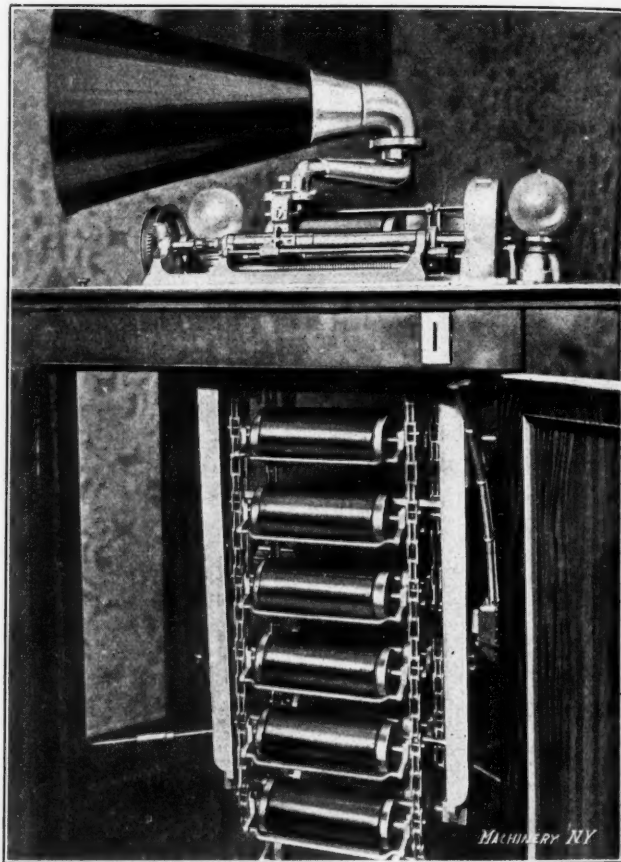
The Iddings "Multinola," or Continuous Phonograph

horn facing the open window to do its malevolent work through the long hours of the stilly night without rest—or hesitation at the most frightful threats.

It is characteristic of American ingenuity to discover and fill wants before they are even vaguely felt by the mass of unthinking humanity. Lo! the wished-for machine is even now in our midst, and the dreadful tortures that were dimly forecasted by hand-worked phonographs will soon, no doubt, be realized by many writhing victims who, cursing inventors and all their works, die miserably to the sound of phonographic ragtime. Behold in the illustration of the "Multinola" by Dr. George L. Iddings of Cleveland, Ohio, a devilishly ingenious mechanism that changes its own records with cunning and despatch, and proceeds relentlessly, having no bowels of compassion whatsoever. The roosters crow and crow again at the dawn; the dogs bark when the moon is full; the cuckoo clock cuckoos, and is done, but the continuous phonograph goes on like the brook—forever. Yea, verily!

* * *

Contracts have been awarded for steam turbines to drive the new 26,000-ton battleships *Wyoming* and *Arkansas*. It has been stated that a combination of turbines and reciprocating engines was considered, but the authorities decided in favor of Parsons turbines.

OLD NEW ENGLAND WATER-WHEEL

ALLEN HAMMOND*

Some interesting features of an old water-wheel which was built by the Franklin Foundry & Machinery Co., of Providence, R. I., and erected in the New England company's mill in the year 1860, are shown in the accompanying engravings. The wheel was started in November of the year of its erection, and, with the exception of about a year, it has run regularly since that time. In spite of its forty-eight years of service, the wheel was in such good condition at the time of its removal, judging from the appearance of the woodwork, that it was capable of running for twenty-five years more. It was of the type known as a breast wheel, and was 24 feet in diameter by 18 feet in width.
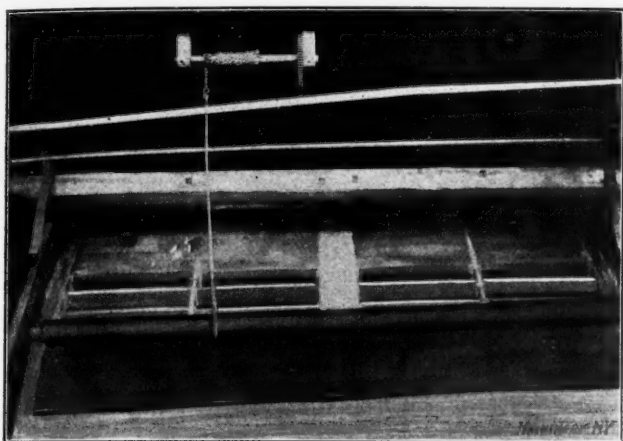

Fig. 1. Curtain Gate which, in conjunction with a Governor, controlled the Flow of Water to the Wheel

The breast or bottom of the flume through which the water entered into the buckets, was approximately 5 feet, 10 inches above the center of the wheel. The flow of water was regulated by a governor having a differential gear which gave power enough to work a long roll on which an "apron," extending across the breast, was wound and unwound up or down on the convex face of the breast. This apron, which is shown in Fig. 1, was made of sheet rubber and was fastened at the lower edge so as to be water-tight. The roll was
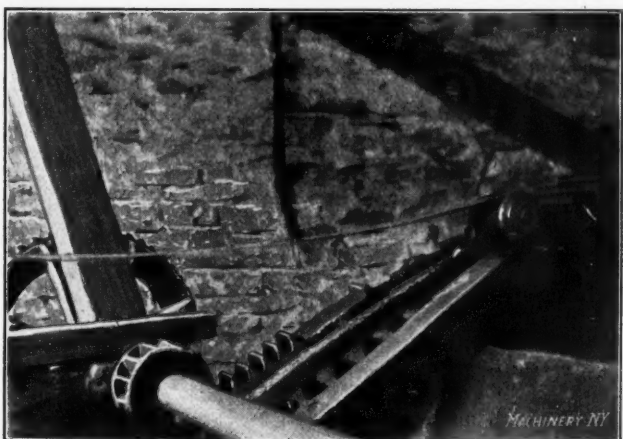

Fig. 2. Rack and Pinion by which the Curtain was wound or unwound

counterweighted and it was moved by a shrouded pinion, which meshed with a rack free to move on the face of the breast. This rack had the teeth cut away at each end, and when the pinion came to this smooth surface, the roll reached the limit of its travel, owing to the lack of teeth on the rack which prevented further movement. The end of the rack was provided with a flange-like tooth or projection, which prevented it from moving out from under the pinion. Both pinion and rack are shown quite clearly in Fig. 2. The counterweight attached to the roll was heavy enough so that after the latter reached the limit of its travel, the pinion would be kept in contact with the rack; hence the teeth of the pinion readily came into engagement with the rack when its motion was reversed by the governor.

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Guide vanes were inserted in the breast so that the water entered the buckets perpendicularly. These vanes, which may be seen in Fig. 1, were made of wood which was driven into castings that formed part of the breast. They were 6 inches

Fig. 3. View of the Back of the Wheel showing part of Driving Gear and Method of Bracing Buckets

wide and 3½ inches apart. The space between the buckets at the top was 10 inches and at the bottom 4 inches, and the angle between each bucket and periphery of the wheel was 36 degrees.

To prevent the air from being pocketed in the buckets, openings were made in the bottom which allowed the air to

Fig. 4. Spokes and Bracing at the Center of the Wheel which was without a Shaft

escape and the lower buckets to be partly filled. These buckets were set into grooves in the rim and were secured in place by spacers and bolts, as shown in Fig. 3, which is a view of the back of the wheel. In this illustration the driving segments on the rim are also shown.
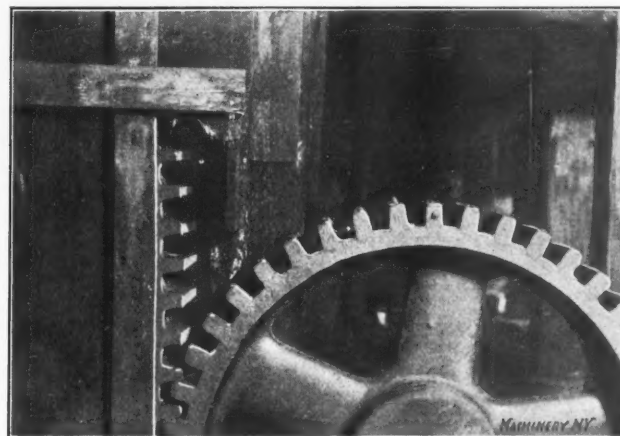

Fig. 5. Section of the Driving Gear, and "Jack" Gear with which it meshed

One unusual and interesting feature of this wheel is that it had no shaft, as will be seen by examining Fig. 4, which quite clearly shows the construction. The spokes and braces rested on flanges which were separated by wooden spacers through which long bolts passed from one side of the wheel to

the other, clamping it together. One of these bolts is clearly shown in the view just referred to. The spokes were 11½ inches by 4¾ inches, while the braces were 4½ inches by 5 inches. The segments of the rim were 11 inches by 12 inches. The bearings or gudgeons of the wheel were 10 inches in diameter by 11½ inches long.

Fig. 5 shows a section of the segment on the rim and also the "jack" gear, which was one of a set of three gears that was used for driving the mill. This gear had 44 teeth, 2½ inches circular pitch, and a face width of 7 inches. The second gear of the train had 114 teeth, and it was meshed with one having 38 teeth. The drive from the second shaft was by belts which ran over pulleys or drums, and some of these belts were as old or nearly as old as the wheel itself. In fact, one is said to have been older, it having been in use since about 1847. This wheel has worn out several sets of segments during its long and useful life.

* * *

ASSEMBLING VERTICAL HIGH-SPEED TURBINES

HOWARD M. NICHOLS[*]

The following method of assembling and lining up vertical steam turbines is employed in one of the large turbine works, and the same general scheme could be used in erecting most any large vertical machine.

The bed-plate is set on a special iron erecting floor and is very carefully leveled, and the turbine is then assembled
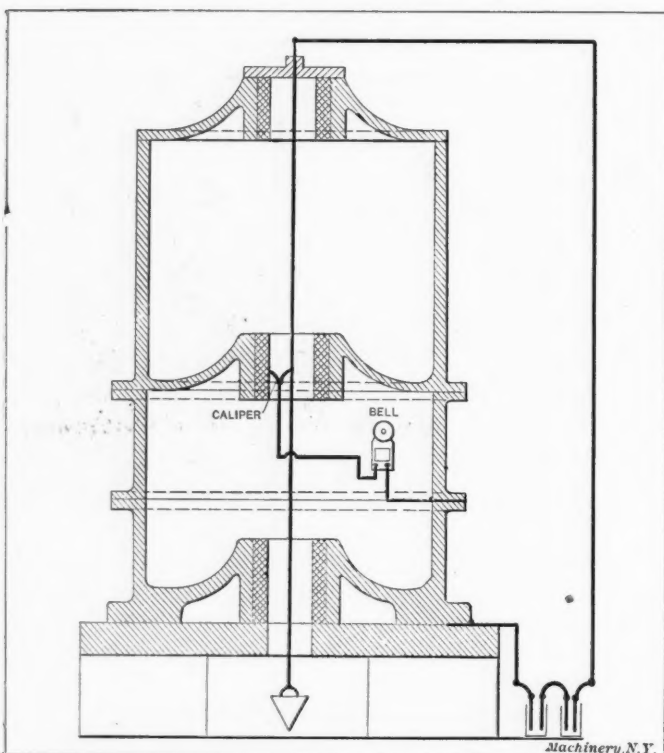
Aligning Vertical Turbine Bearings by the Aid of an Electric Caliper

without the shaft and rotating parts. The wheel casing, bearing brackets, bearings, generator stator, and all other stationary parts are bolted in place. The bolts are left a little slack so that the parts can be slightly shifted during the process of lining up. A length of steel piano wire is weighted with a heavy plumb-bob and is suspended from the exact center of the top bearing, as shown in the accompanying illustration. Since the machine has been carefully leveled during the process of erection, the piano wire will locate the exact center of the shaft. The wire is suspended from the top bearing by a block of hard wood and is not allowed to come in contact with any metal part. The end of the piano wire is connected to one pole of a few cells of dry battery, while the other pole of the battery is grounded onto the frame of the turbine. One binding post of an electric bell is also grounded onto the turbine frame, and the other is connected to a pair of inside calipers by a long flexible lamp cord as shown. These calipers are used to locate the middle and

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lower bearings central with the center of the turbine shaft, as represented by the piano wire.

In calipering, whenever the calipers just touch both the inside of the bearing and the piano wire, the bell will ring and thus give the workman a better indication than he could obtain by the sense of touch. If it is so desired, a small battery lamp can be used in place of the bell with equally good results. After the bearings are located exactly central with the center of the shaft, the parts are doweled together and then taken down and reassembled with the shaft and other rotating parts in place.

* * *

GAS ENGINES IN SHOPS

A. S. ATKINSON[*]

Generally speaking, the gas engine is rapidly becoming an important factor in machine shop work, and the facility it furnishes in operating cutting, stamping and machine tools, makes it of widespread importance to the trade. Until quite recently the installation of any kind of gas engine for shop and factory purposes was of such limited scope that the question of cost and maintenance was not seriously considered; but now that the gas engine for small as well as large shops has come to stay, any data that will throw light upon the subject should be of more or less value.

Economy in operation is the one thing aimed at, and this, in the case of the gas engine, means an economy in fuel. In my experience with gas engines in shops where only a part of the whole number of machines are in use at one time, the mistake is frequently made of installing an engine which is too large. Suppose, for example, a shop with half a dozen machines requires a full 15-horse-power engine to drive them all at once; but an examination of the records shows that only half these machines are in operation for the greater part of the time, and only occasionally does the work demand the running of them all at once, and then only for a limited period. What power engine should such a shop have to produce the most economical results? This is a point that engineers and manufacturers differ on. One will say the full 15-horse-power, and another ten or even eight, which will allow a fair margin over the average requirement. Here is an experience of the writer. A shop that had run along nicely with an 8-horse-power gas engine was enlarged by the addition of three more machines. The question arose as to the increase of the power. One engineer advocated the withdrawal of the inadequate 8-horse-power engine and the substitution of a 15-horse-power engine. Another recommended the installation of an auxiliary engine of 7 horse-power. A compromise was made by purchasing a small 6-horse-power motor, which could be coupled and uncoupled by belt to the line shafting as needed. The economy of this was shown in the first year's work. The auxiliary engine was used only 120 hours that year. For the rest of the time the old 8-horse-power engine did all the work, for the work was of such a character that only a part of the total number of machines was in use at once during the greater part of the time.

There must be some allowance for overload made in every shop, or otherwise work during rush times must be handicapped. It is unsafe to depend upon an 8- or 10-horse-power engine in a 15-horse-power shop, but does not the single big engine waste fuel where a medium-size one and a smaller auxiliary will save it? This is a question that a shop manager must consider carefully. To get fuel economy out of an engine, it should be run at something like its normal capacity. We cannot expect economy in using an engine twice as large as is required to do the normal work. On the other hand, in a shop where nearly all of the machines are needed in operation for the greater part of the time, the problem is easier of solution. The big engine is then more economical than two smaller engines, as there is less waste through friction and slipping, and less expense in operation in other ways. The cost of maintenance of two small engines is greater than a single big one of equal horse-power.

The location of the gas engine is also of importance. It should be somewhere near the middle of the long line of

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shafting if the different machines require about the same amount of power. An engine installed at one end of a line of long shafting must of necessity lose much of its effectiveness. Where a smaller auxiliary is used this should be installed with a view to running special machines not often in use. These should be grouped, so far as possible, at one end of the shafting, and in such a way that when the auxiliary is started up it will exert its power directly upon these machines. This means an equipment which will permit the cutting off of at least a part of the line shafting when not needed. It costs a little more in the initial installation to secure this result, but the saving in fuel far more than counterbalances it in the end. If there is a heavy planer at one end that requires considerably more power than any of the other machines, the engine should be located pretty close to it, but on the side nearest the other group of machines.

The gas engine has not been satisfactory in many shops through the inability of the operators to understand the new power plant. Gas engineering is a distinct and new branch, and it is impossible for an old steam engineer or one accustomed to electric drives to change to the gas engine without experiencing some difficulties. Not infrequently, engineers look upon the gas engine as such a simple machine that anybody can understand its operation without much previous study and experience. It is one of the simplest and easiest engines to operate, but it does not follow that it can be run by an ignorant man, and without some technical skill. To some extent the gas engine manufacturers are largely at fault; in their zeal to advertise their goods they say that a child can run their engines and that it takes no skill to manage them. Nothing is further from the truth. Your gas engine can get out of order and run poorly, consuming twice as much fuel as it should, if you do not understand it. The symptoms of gas engine troubles should be understood just as much as those of the steam engine or electric motor. In my experience with gas engines for shop work I have found that the symptoms of trouble are generally indicated by pounding, excessive fuel consumption, back firing, heavy explosions at the exhaust, smoke, poor speed regulation, difficulty in starting, and general lack of power. These symptoms of trouble should all be understood by the engineer, and if understood the difficulty can be quickly regulated. The life of a gas engine depends entirely upon how well it is handled at all times, and here is where the skill of the operator counts. With a thorough knowledge of the meaning of the different symptoms of trouble, the engineer can quickly apply the remedy. Pounding is generally due to the fact that the engine and gasoline are too cold. This trouble is particularly noticeable in winter and in cold climates where the engine is exposed. In a shop where the heating is good it is not so noticeable. The air intake pipe may be too cold, and the gasoline for the first charge may also be too cold. Sometimes the pounding at starting is due entirely to the jacket water being turned on too freely or too soon.

Where there is excessive fuel consumption it can be stopped by a little study of the conditions. The most common cause is the use of poor or dirty gasoline which has not been strained. Straining of the fuel should always be attended to. Water in the gasoline or cylinder will cause excessive waste. Sometimes the waste is due to defective cylinder or cylinder head castings; in such cases there is no remedy except to put it up to the manufacturers and make them furnish new parts. Again the excessive consumption of fuel may be caused by cylinder gaskets being leaky or, as sometimes happens, by their being blown out. The remedy may be applied in such cases without much trouble.

Back firing is often simply the result of incorrect setting of the spark or valve mechanism, and until this is remedied the trouble will persist. If back firing is noticeable, look for the cause first in the spark, and see if it is not out of time; in the make-and-break system the spark points may not touch. If the ignition system is all right, then examine the exhaust valve which may be out of time, or as often happens, may not close or fully open. Finally, see if the governor mechanism is not out of adjustment. Any one or all of these

troubles may be caused by incorrect setting at the beginning, and proper adjustment will remove the whole difficulty. Heavy explosions at the exhaust may be due to defective ignition or because the mixture is too weak. Smoke at the end of the exhaust pipe generally means that lubricating oil is being wasted. If the smoke is of a bluish color this is quite evident, but if it is black it indicates that the mixture is too rich. If the smoke appears at the open end of the cylinder there may be a sand hole in the cylinder or a leak past the piston ring.

Poor speed regulation may be caused by defective ignition or because the governor is not properly adjusted. Again it may be caused by lack of proper lubrication of parts, or incorrect mixture. Sometimes moving parts are gummed and bind so that the regulation is very poor. If there is any lost motion in the moving parts the speed regulation must be imperfect.

Difficulty in starting is sometimes experienced and causes a great deal of trouble. This may be due to any one of many troubles, the removal of which may prevent other troubles developing later. First ascertain whether the fuel is being supplied in sufficient quantities. This is the most fruitful cause. Next examine the ignition system, and then ascertain if the mixture is properly proportioned. A cold engine or cold gasoline will sometimes cause difficulty in starting. If batteries are too weak, the spark coil defective, or if the sparking circuits are short circuited by dust and dirt, naturally there will be trouble. Too much emphasis cannot be placed upon the necessity of keeping the ignition system clean and in perfect order. This is the main part of the system, the nerves of the engine, as it were.

General lack of power may be caused by insufficient fuel or incorrect mixture also. Overheating and friction of engine parts are other fruitful causes. Likewise insufficient cooling water and insufficient lubrication will cause general lack of power in the engine. Frequently the whole trouble can be traced to a poor grade of lubricating oil which gums the moving parts and prevents free action. Heating of the piston by pre-ignition has caused many an engine to give poor results. Another thing to look for is the heating of the piston by escaping gases. There may be leaks in the compression chamber which may be the result of worn or bent valve stems or weak or broken valve springs. In new engines this trouble will not be noticeable, but others equally important will show. For instance the piston rings may not be true in circular form or they may be set with all breaks in line, thus causing a leak. In new engines sometimes the piston rings stick in the grooves and cause a constant leak. If the valve cages are not properly packed or ground into place there will be a general lack of power. In old engines dust or dirt in the carburetor, air passages, or admission valves, may be responsible for the trouble.

One does not have to study these possible defective points long before being convinced that an intimate knowledge of the gas engine and its parts is essential to good economical operation. Many times the same defect shows itself in one or more symptoms, and to remove the cause is to give the engine immediate freedom of action. Sometimes, for example, an exhaust pipe causes all of the symptoms. It is too long, too small, or has too many bends in it to permit a free expulsion of the exhaust gases. As a result the engine is constantly clogged in its operation, and other troubles will quickly set in. The only way to handle a gas engine is to find out the trouble when the first symptom shows itself. Then its life will be greatly prolonged, and there will be an economy of operation.

* * *

What are claimed to be the two largest shears of the lever type ever built have recently been completed by the Mesta Machine Co. for the Indiana Steel Co., to be used at the steel plant at Gary, Ind. The knives of the shears are 36 inches long and will make 12 cuts per minute, cutting off cold soft steel 6½ inches square or 7 inches round. Each of the machines is driven by a 150 horse-power induction motor. The total weight of each shear, not including the motor, is 112½ tons.

MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

JANUARY, 1910

IMPRACTICABLE IDEALS IN INDUSTRIAL EDUCATION

There is danger that the leaders in the movement for in-
dustrial education will aim too high, and that the courses of
instruction will suffer from the same false reasoning which
has based our high school courses on college entrance require-
ments. There is grave danger that the primary aim will be to
enlarge on fundamental principles in a way that would appeal
to the exceptional boy who is to become a superintendent or
general manager, instead of helping the average workman
directly with the problems of his daily work.

The danger of such a course lies in two directions. In the
first place, it is exceedingly difficult to keep boys interested
in studies which they see no opportunity to apply practically.
In the second place, there is the ever-present possibility of
spoiling good workmen by inspiring them with ambitions for
positions which they are incapable of filling.

There is no injustice to the exceptional boy in this setting
of a low standard for industrial education. He can readily be
interested in the instruction, elementary though it may be,
and once in contact with other students of lesser abilities,
his own attainments stand out in high relief, permitting him
to be picked out from the bunch and given such advice and
assistance as he may need in preparing himself for better
things.

Don't aim too high.

* * *

APPRENTICESHIP CONDITIONS

The difficulties which surround the apprenticeship question
have been a subject of discussion for many years, and will
continue to be until employers and apprentices get closer to-
gether than they now are on some points of difference. On
the manufacturers' side we hear of the reluctance of young
men to learn a profitable trade, and the difficulty of holding
them to the terms of apprenticeship contracts. The young
men look at the low wages they receive as apprentices, and
make no allowance for the time spent in teaching them a trade
which will greatly increase their future earning capacity. If
the average young man can earn a couple of dollars a week

more in some other and possibly easier occupation, he is sel-
dom likely to sacrifice that amount of money to acquire a trade
at which in a few years he can earn twice as much as in some
occupation that offers little chance of development. The ques-
tion really narrows down to this—Is the manufacturer willing
to pay more than his apprentices' services are worth to him,
either on account of the general benefit to his industry, or
because it will pay him in future to educate such employes
for his own organization? That this policy does pay has been
satisfactorily demonstrated by many of the largest concerns in
the country, who still maintain their apprenticeship system
at more or less loss to themselves. The present need is for an
action of the employers which will attract the boys and hold
them.

The indentured apprentice of fifty years ago would be as
much out of place under present conditions as the spinning
lathe, the hand loom and the flail of our grandfathers' time.
The master-and-servant situation was but one step removed
from the days of the bond slave, and many of the cruelties of
slavery were felt by the old-time apprentice. He was poorly
paid, had to work long hours, often slept in the master's house
and ate at his table, and could be corporally punished for de-
linquencies. To-day, of course, most of these conditions no
longer exist. The manufacturing business has developed be-
yond the wildest dream of the old-time employer of a few men,
and the apprentices of to-day are treated as well as journey-
men in the matter of working hours, shop surroundings and
other working conditions. But in addition to these improve-
ments, apprentices of the desirable sort apparently must be
attracted to the machine shop by higher wages and an educa-
tional campaign which will clearly make known to the average
boy and man the possibilities that lie before the good ma-
chinist and toolmaker, as compared with other trades or the
professions. Although in some places trade union rules are a
strong deterring force, low wages at the start and ignorance
of the chances for improvement are much to blame for the
reluctance of young men to enter these trades. The boy sees
chiefly the grime and the forbidding conditions that are com-
mon to many shops, and does not understand that brains and
ability count for as much in those gloomy interiors as in the
counting house or department store, with the chances for
rapid promotion and good wages much greater.

* * *

THE FUTURE OF THE MACHINE TOOL INDUSTRY

A prospectus recently sent out by one of the great New
York banking houses setting forth the stability and value of
a new security which they are offering to investors, inspires
a comparison between substantial enterprises of that character
which offer legitimate opportunities for investment, and the
machine tool industry as a whole.

The development of manufacturing in America is still in its
infancy, notwithstanding the enormous investment already
made therein and the number of men employed. Every in-
crease in its many ramifications will call for more and more
of the tools required for building all kinds of machinery—
that is, machine tools. The automobile industry alone has
absorbed a large number, and will continue to absorb more
for some time to come, although no doubt in a diminishing
ratio. Then, supplementing the demand from automobile
manufacturers, will come that of the automobile and gas en-
gine repair shops which in time will dot the country roads in
somewhat fewer numbers, perhaps, than the blacksmith shops
now employed in shoeing horses and repairing wagons and
farming utensils—and each of the former will require at
least one lathe, shaper, drill and grinder.

The railroads are large users of machine tools already; but
their potentiality as buyers in the machine tool market is
enormously greater. The present equipment of many railroad
repair shops is of the poorest character imaginable, the tools
frequently being of a type obsolete twenty or thirty years ago.
The development of high speed steel and the great increase in
power and capacity of locomotives, have already put many of
these old tools out of commission, and still greater numbers
must be thrown out and replaced by modern tools as soon as
railroad earnings warrant the necessary expenditure.

In several other directions we can see a great and widening demand for machine tools—a demand that will be larger than the present manufacturers can supply unless the capacity of their plants is greatly increased. Many new concerns will therefore start the manufacture of standard and special machine tools within the next decade, because the industry is a stable and profitable one, and as the field widens its product is less liable to fluctuations in demand than heretofore. The machine tool business is therefore one to inspire the confidence of hard-headed business men who want to know that their money is safely invested where it will yield a fair return and multiply.

Much depends in the machine tool industry on business ability,—more than mechanics generally think; but the talent required for the organization and management of new machine tool concerns exists in the trade, and the next ten years will doubtless see many mechanics who have the ambition and ability leave the bench and strike out for themselves, at the head of new enterprises.

* * *

HAND AND AUTOMATIC TURRET LATHES

In December MACHINERY we published an article on shop practice which included many excellent examples of operations on the hand-operated turret lathe. In the current number is an article containing descriptions of several equally interesting operations performed on the automatic turret lathe. While the work in the two cases is somewhat different, it is conceivable that if these two shops should swap managing officers, the methods of machining would change with the management, and that the work, in time, would be changed from hand to automatic machines and *vice versa*.

The condition mentioned is an important one. It meets every machine manufacturer in the country, and a close understanding of the subject is most essential. There is, of course, no fundamental competition between the two methods of machining. Each is supreme in its own field, and it is only on work which is on the border land between the two classes that any uncertainty should be felt. We are going to try to present, briefly, the considerations which should guide the manufacturer in deciding to which class his work belongs.

First let us consider the advantages of hand-operated machines. The hand turret lathe receives constant supervision which renders it less liable to shut-downs from any cause save that of neglect of duty. Accuracy in the work can be maintained with more rapid tool deterioration, and consequently with heavier cuts, due to the feature of constant supervision, combined, in a well-designed machine, with ease in changing and adjusting the tools. Changes of tools and adjustments can be more quickly made, and less complicated tools are required, profitably adapting the machine to smaller lots than the automatic machine can be rigged up for. The same factors also facilitate changes and improvements in the product.

Another and most important advantage of the hand machine is the higher output possible per dollar of capital investment, because the machine itself and the tool equipment are less expensive, and under many conditions a higher output per machine is possible. Again the profitable use of the hand machine on small lots permits the rapid flow of work through the shop, with a consequent reduction of the capital tied up in work in progress. All these factors—the less expensive machines and tools, the possibly smaller number of machines, and the smaller stock of rough and finished parts—are reflected in smaller and more compact buildings, with the consequent reduced expense for interest, insurance, taxes, salaries and other overhead expense.

The advantages of the automatic machine may be summarized as follows: It makes possible a lower labor cost per piece, and this is true practically in all the conditions under which the automatic machine would be considered. It may be arranged to take full advantage of the possibilities of using multiple tools, and on a large proportion of turret machine work this means that the hand machine will be unable to produce the same output per machine, in spite of the closer personal supervision which the latter receives from the workman. In the matter of accuracy it may be assumed that with properly arranged tools and proper setting up, the invariable mechanical action of the automatic machine is highly suited to the production of accurate work, uniform in all its important dimensions.

Besides those just mentioned, the automatic possesses other advantages over the hand machine which must appeal to shop managers from the standpoint of administration. It does not cease to be productive, even if the operator leaves it for a time, and it does not stop until its work is completed. One skilled mechanic can supervise the work of a large number of machines, and the direct attendance of the machine, for keeping it supplied with work and inspecting its operation, can be left to a less expensive grade of labor. This consideration means also a more flexible organization, as it is easier to shift men from one machine to another.

High production for a given piece on the hand turret lathe comes in part from the skill of the operator on that particular piece, and is checked for the time being by shifting to work of another character. The same considerations also apply in the matter of breaking in new men to the work. Attendants for the automatic machine, sufficiently skilled for its requirements, can be obtained with little trouble. The importance of these considerations can best be understood by those actively engaged in shop management.

In balancing the various advantages and disadvantages mentioned above, the shop manager should take into consideration the conditions covering his particular case, among which may be mentioned the following: Is the work of such a character that the multiple cuts obtainable from the automatic machine can be used? Are changes in the design or character of the work sufficiently frequent to make the adaptability of the hand machine an important consideration? Is the product built in sufficiently large lots to make automatic machines profitable? Is the capital available for the business sufficient to warrant larger initial expense when the more expensive machines figure out to be cheaper in the long run? Is the product of the shop, as determined by careful analysis of accurate cost accounts, of such a character that the labor cost is relatively high, or relatively low, as compared with the charges for material, overhead expense and interest? What are the labor conditions? Are wages for good men relatively high or low? Is the working population a shifting one, and is there a large supply of skilled workmen to be drawn on?

It will be seen that this problem is one difficult to solve by purely logical, mathematical processes of reasoning. The factors are too many and too complicated. Reasoning will carry the shop manager part way toward his conclusion. But when all the facts in the case have been gathered, in coming to a final decision from them that necessary and indefinable attribute we call "judgment" will have to be invoked.

We cannot refrain from calling attention to one point in which the automatic machines, in general, have a fundamental advantage over hand-operated machines engaged in the same work. This consideration may be criticised as being a purely ideal one which ought not to be considered in a practical discussion of the subject such as we have been carrying on. It is a consideration, however, which inevitably strikes the mind of the observer who has an opportunity to compare the conditions in two shops where both classes of machines are being operated with high efficiency. With hand operation, the workman tends to become the servant of the machine. The possibility of increase of production through constant supervision is so great that the operator is kept constantly on the alert in changing feeds, speeds and adjustments. With automatic operation, it is the man who is the master, and the machine the servant. It is a sight distinctly inspiring to see banks of automatic machines steadily chewing away, while the operator walks leisurely from one to the other, putting in a new piece here, examining the condition of the tool there, and occasionally changing the adjustment. This consideration, we believe, brings the automatic machine directly in line with the current of human progress.

* * *

Why don't the grinding machine operators wake up and write something of general interest on grinding?

PRACTICAL SAFEGUARDS IN THE NATIONAL CASH REGISTER CO.'S PLANT*

ETHAN VIALL†

No plant in the world is more up-to-date in every respect than is that of the National Cash Register Co. at Dayton, Ohio. It has been looked upon as a model for years, and its fame as such has attracted visitors from all over the world, over fifty thousand being shown through the various departments annually.

Every effort has been put forth and no expense spared to beautify the factory grounds, a noted landscape gardener being

other man just as good," has no place here; but the policy toward the employe might be expressed in this way: "We have spent time and money to train this man (or woman) in our way of doing work, and it is far easier and better to take care of him and keep him in good shape physically and mentally, than it is to neglect or mistreat him and, in consequence, have to break in a new one every few weeks or months, thereby lowering our average of efficiency, quality and output." The different ways by which all this is accomplished are almost infinite, but it isn't within the scope of this article to deal with anything more than those methods or devices by which life or limb are protected, though in
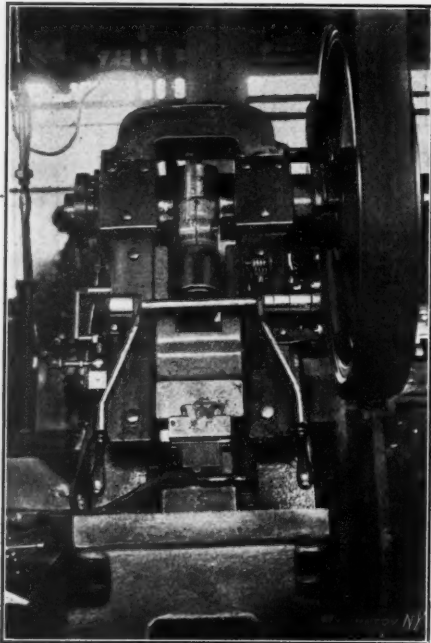

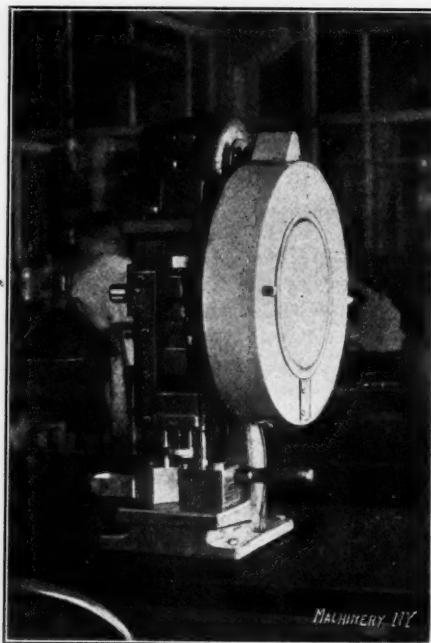Fig. 1. Two-handed Trip for Punch Press, which proved Defective

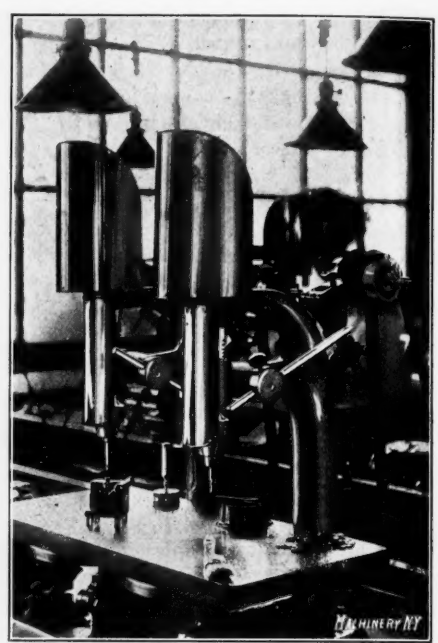Fig. 2. Guard over Pinion and Gear of Motor-driven Press

Fig. 3. Hair Guards on Small Drill Presses which are operated by Women

employed for the purpose. Employes are encouraged to buy their own homes and are given expert advice as to the best way to make them attractive. Good wages are paid, and women employes are given shorter hours than men and a recess twice a day. Rest rooms are also provided for them, and a doctor and trained nurse are within easy reach. The men are allowed twenty minutes for one shower bath a week in winter, and forty minutes or two a week in summer at the company's expense, there being 228 series of showers in the factory. No person with a contagious disease is allowed to work. Four-

many cases the margin between mechanical safeguards and sanitary ones is so narrow as to be practically indistinguishable and no attempt will be made to hold strictly to mechanical devices as such are usually defined.

Probably no class of machines, unless for woodworking, has been the cause of more serious accidents than punch presses, yet no other class of machinery has had fewer successful safety devices. In many cases, on the more powerful machines, even the gearing, now almost universally covered on other machines, is left without a guard or shield of any kind,
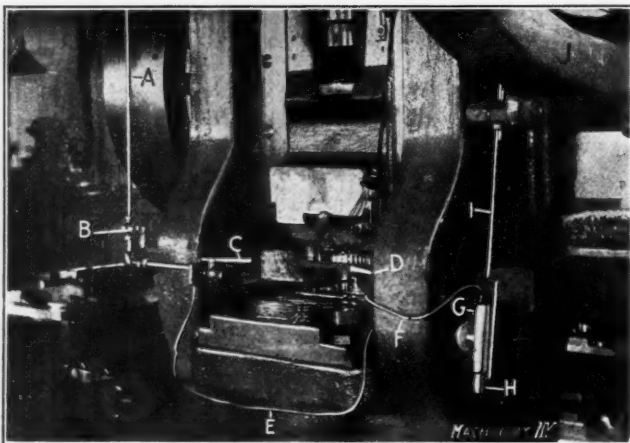
Fig. 4. Improved Two-lever Pneumatic Press Trip

Fig. 5. Protective Shield covering Fly-wheel Spokes

fifths of the wall space is glass, affording plenty of light and saving the employes' eyes. The ventilating system is as nearly perfect as modern science can make it. The company has its own laundry and furnishes clean towels and aprons twice a week, and in every possible way the employe is taken care of, not merely because the company wants to be philanthropic, but because it is sound business policy. The old, revolting idea that found expression in: "When he's dead we'll get an-

a man's finger or his arm hardly being considered worth looking out for, regardless of the fact that one damage suit is likely to cost enough to buy a hundred or even a thousand guards. Carelessness and indifference on the part of employes has, to some extent, been responsible for the lack of proper safeguards, for what an employe doesn't insist on or doesn't want, isn't usually given him, especially if it costs the employer anything. Instances are common where an operator, after a press has been fitted, at considerable expense, with an automatic lever or guard to protect the fingers or

* See note referring to the safety appliances used by the U. S. Steel Corporation, in MACHINERY, February, 1909.
† Associate Editor of MACHINERY.

hands from the descending punch, has, at the first opportunity, thrown it aside and gone back to the old unguarded way. Too much trouble is the verdict, but it *isn't* too much trouble if the device is going to save a man's hand or arm, no matter what he says of it.
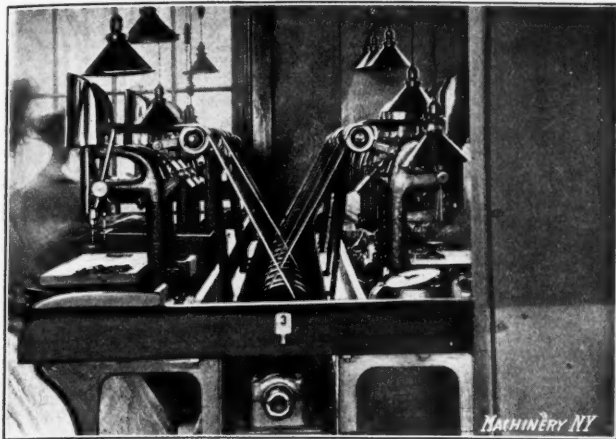
Fig. 6. Hair Guards and Arrangement of Belts and Pulleys on Small Drills

Only a few instances of discarded devices serve to convince a thinking foreman that any appliance intended to prevent a man getting his fingers under a punch, must be absolutely "fool-proof," and to devise something of this kind has been one of the hardest problems that the shop officials of the Na-
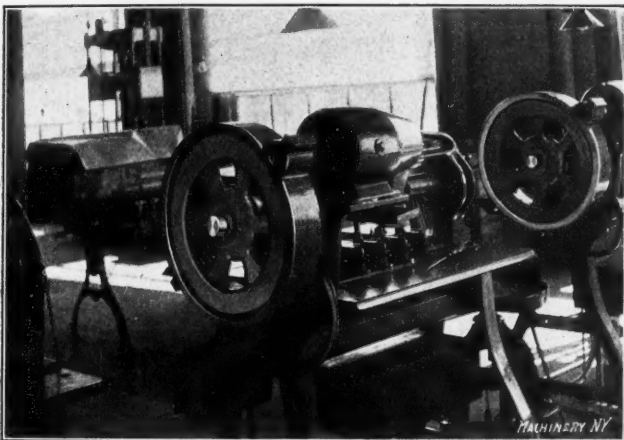
Fig. 8. Neat Style of Gear and Pinion Covers

tional Cash Register Co. have had to solve, but recently they hit upon what appears to be the only really successful, fool-proof appliance yet devised. It has taken a long time to work out and correctly apply the idea involved, but the principle is very simple, the whole idea being to *make the operator use*

Fig. 10. Corner of a Rest-room for Women Employes

*both hands to trip the press and to make it impossible for him to do so unless he does use both hands.* That is the whole thing in a nutshell, and the idea is being applied to every punch press in the plant and, of course, in compelling a man to use his hands to trip the press, the dangerous foot treadle

is discarded and one great source of accidents thereby eliminated, for it is so easy for something to fall on the treadle at the wrong time or for a man to stumble on it or else press his foot down unintentionally.

The first application of a device embodying the two-handed
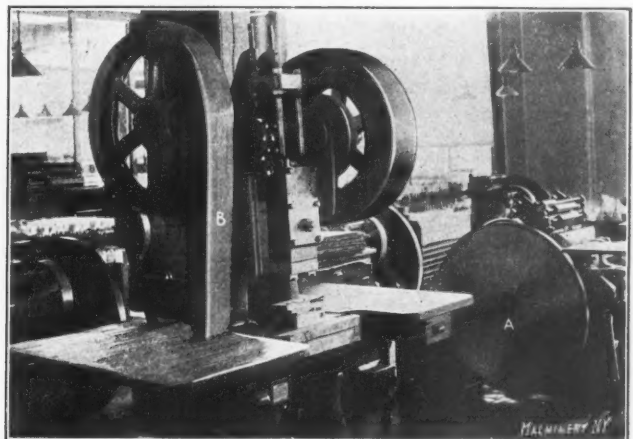
Fig. 7. Belt Guard and Fly-wheel Dress Guard

trip idea was on a punch press fitted with a forming punch and die, and is shown in Fig. 1. This was purely a mechanical device. Both levers had to be pulled to trip the press, as the pulling of one alone would not accomplish it, but as this device soon proved to be anything but fool-proof, it will not
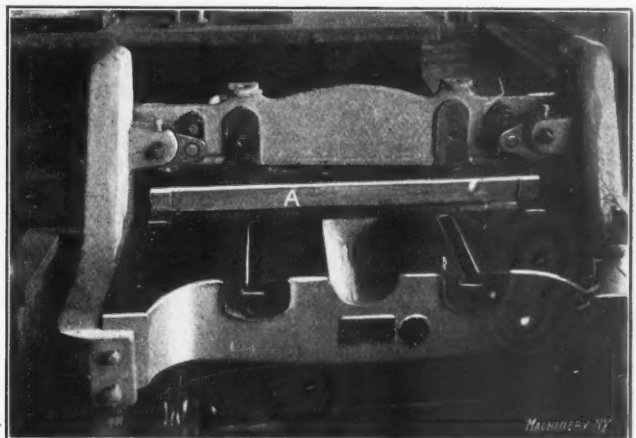
Fig. 9. Finger Guard on Small Trimming Shears

be described in detail. An additional safeguard on this machine consisted of an automatic air valve mechanism (shown on the left side of the press frame) and a hose which was so arranged as to direct a powerful jet of air onto the punching and blow it out of the die as the ram raised. The
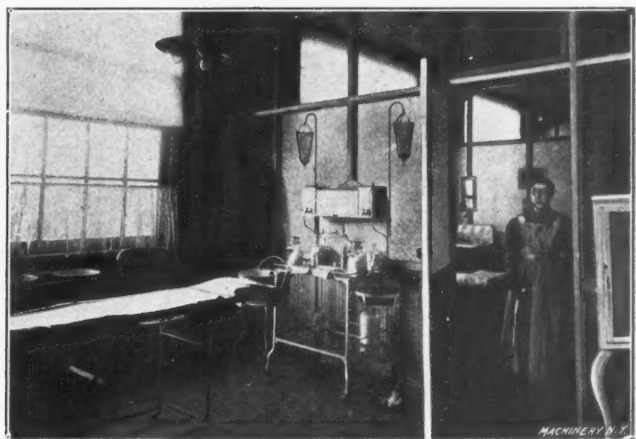
Fig. 11. View of a Corner in the Shop Hospital

principal reason for condemning this lever system was that the operator, to gain a fraction of a second, would, unless watched, prop out one of the handles with a stick and work the trip with one hand, for which there was no valid excuse as the company's piece-work rates allowed a very liberal mar-

gin; nevertheless the fact remained that the levers could and would be tampered with at the first opportunity, so the next move was the fitting of the pneumatic device to the presses, shown in Fig. 4, and this is practically the form of trip that is being put on all the machines at the present time. Refer-
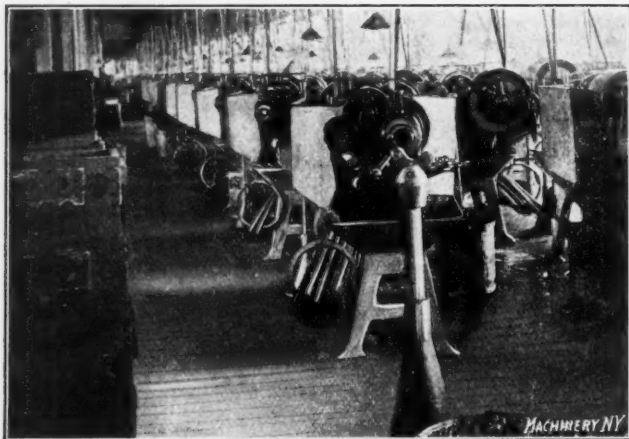
Fig. 12.　Battery of 340 Automatic Screw Machines, equipped with Splash Guards

ring to the engraving, A is the air supply pipe containing air under heavy pressure; B is a cut-off valve; C is the left-hand trip-valve lever, and D is the right-hand trip lever. Both trip-valves are of the same pattern, and are connected by the small air pipe E. The air pipe F leads from the valve D to the
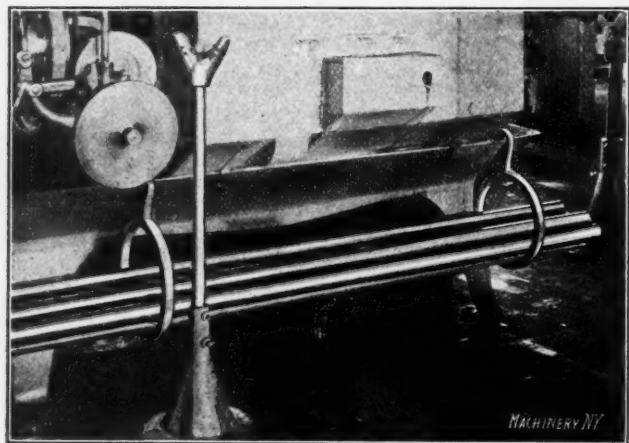
Fig. 13.　Safety Stock Rack on Screw Machine

cylinder G, which is so arranged that when air is let into it the plunger H is forced downward, pulling the rod I with it, and thus causing the press to trip. Now to operate this trip, the line valve B is first opened, letting the air in as far as the valve C; but the pulling of lever C cannot trip the press,

Fig. 14.　View of Jig on Milling Machine, showing Clearance between it and the Cutters

as the air cannot reach the cylinder until lever D is pulled, and on the other hand, the pulling of lever D alone cannot trip the press, since valve C closes automatically and shuts off the supply. It is plain, then, that if both valves are arranged to close automatically the instant the levers are released, it

is impossible to trip the press unless both are held open at once. The form of the levers themselves and the angle at which they project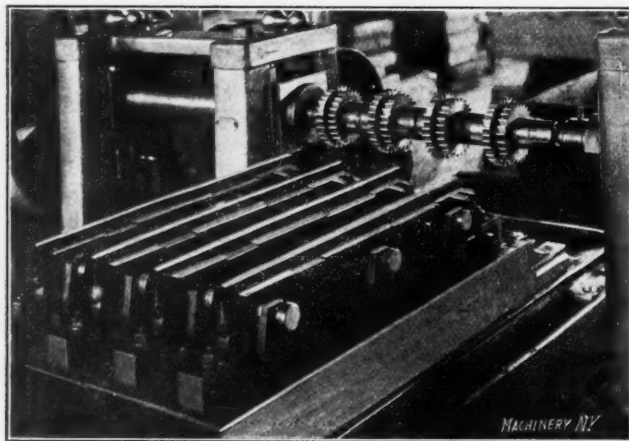 when the valves are open, make it highly improbable that they can or will be successfully propped open. At J, in this engraving, is also shown a partial view of an excellent type of gear guard. Not only are all gears guarded as they should be, but all fly-wheel spokes are covered, where they are low enough to catch anything, as shown in Fig. 5.

In Fig. 2 is shown a good example of a covered gear and pinion on a small motor-driven press in one of the women's departments. Wherever women are employed in a shop, additional safety precautions must be taken on account of long fluffy hair and flowing skirts, and in Fig. 3, are shown two small drill presses with shields to prevent hair catching in the spindles or belts, and in Fig. 6 is shown a compact battery of these drill presses equipped with hair guards. These guards are also very effective in preventing oil being thrown
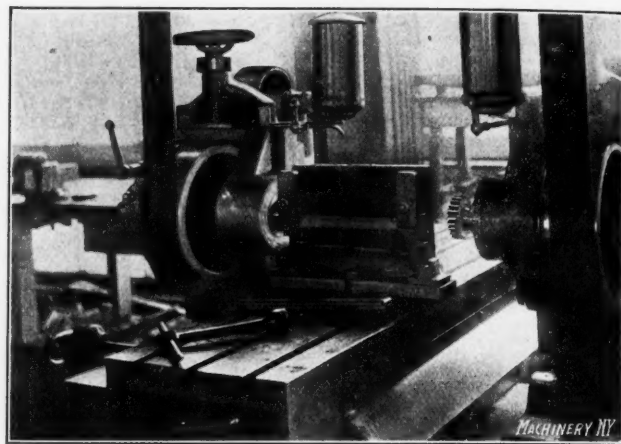
Fig. 15.　View showing Position of Milling Fixture with Reference to Cutter, when Stationary

on the operator. The driving belts and pulleys are arranged in such a way that it is impossible to get caught in them in any manner.

At A, Fig. 7, is shown how the low fly-wheels are guarded to keep the skirts from catching in them, and at B is shown a
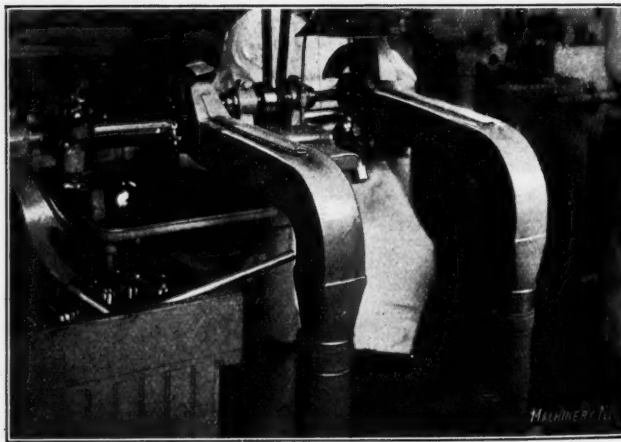
Fig. 16.　Dust Pipes and Wheel Guards on Universal Grinder

good belt guard. No overhead belts of any kind are allowed in the women's department, all driving being done by carefully boxed motors, and where these motors are mounted on the machines, they are carefully covered as in Fig. 8, and if belted in any way, the belts are guarded.

To keep the operator's fingers from under the blade of the light trimming shear, Fig. 9, the guard A, has been fastened to the bed, the opening being high enough for any possible work, but not high enough for fingers.

In connection with the brief mention of the employment of women, one of their rest rooms is shown in Fig. 10, which is provided with chairs, cots, lounges and other comforts so that they may rest or lie down at any time, if sick or indisposed. In Fig. 11 is shown one corner of the hospital, where a trained nurse is always on duty during working hours, and a regular physician is within call at any time in case medical or surgical aid of any kind is needed. He also comes to the shop

hospital at a certain time each morning to prescribe for minor ills, if necessary.

Going now to the automatic screw machine department, with its three hundred and forty automatics, we find guards over gears and every other dangerous part of the mechanisms, and huge pans at the back and front of the machines, as in Fig. 12, to prevent the floor from becoming slippery and dan-

while placing or removing the parts. A good example of this type of jig is shown in Fig. 14. In many cases the reversing of the table is automatic, but in all cases plenty of clearance is insisted upon, and where possible the jig, when at rest, is back of the cutters as in Fig. 15.

Great care is taken in the tool grinding room to have the exhaust pipes arranged so as to carry off all dust. In Fig. 16
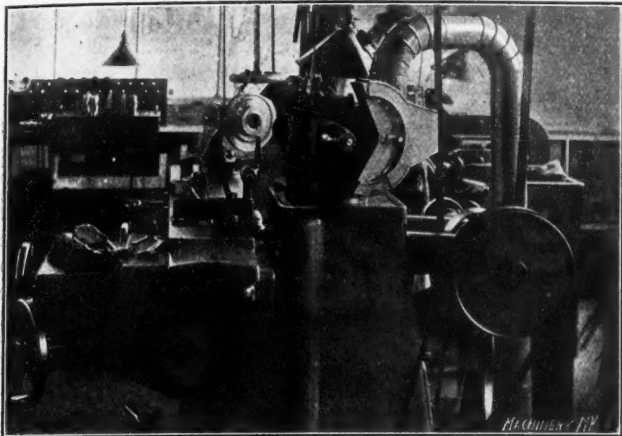
Fig. 17. Dusthood and Exhaust Pipe on a Swivel-head Grinder
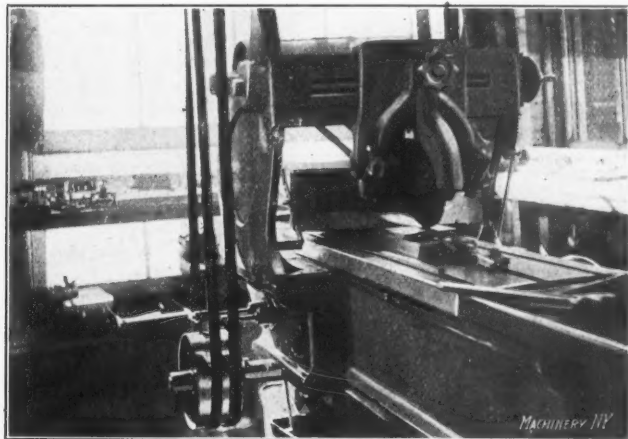
Fig. 18. Surface Grinder with Wheel Guard and Dust Funnel
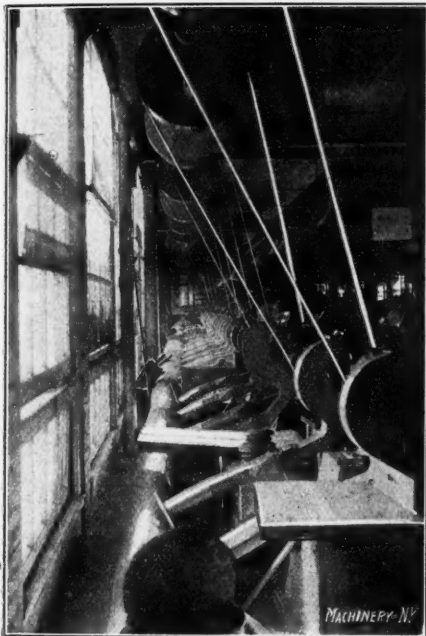
Fig. 19. Exhaust System in Polishing Room
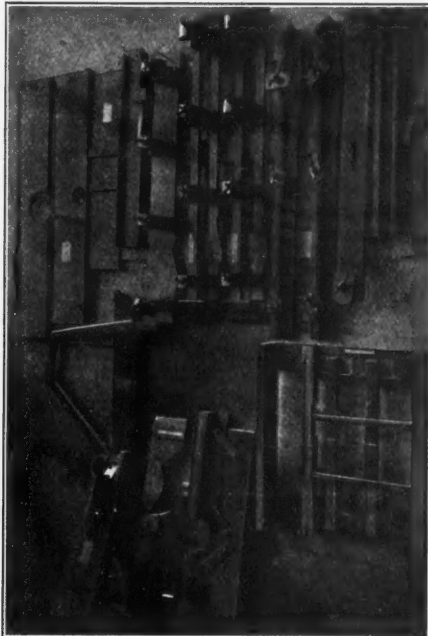
Fig. 20. Wood-working Jigs and Guards
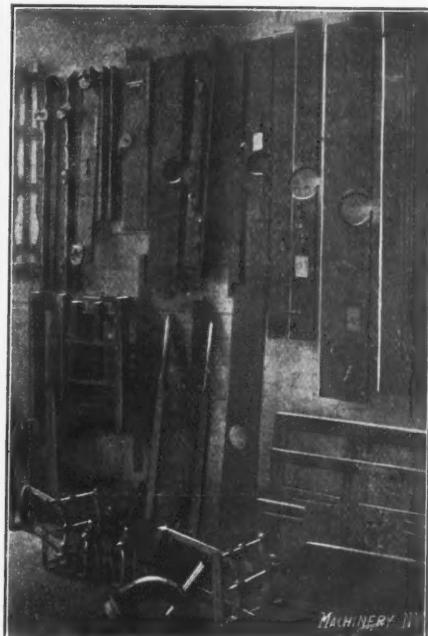
Fig. 21. Other Wood-working Jigs and Guards
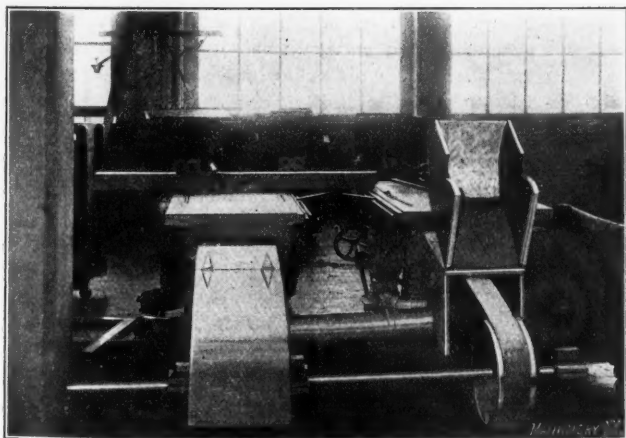
Fig. 22. Belt and Pulley Covers in the Wood Shop
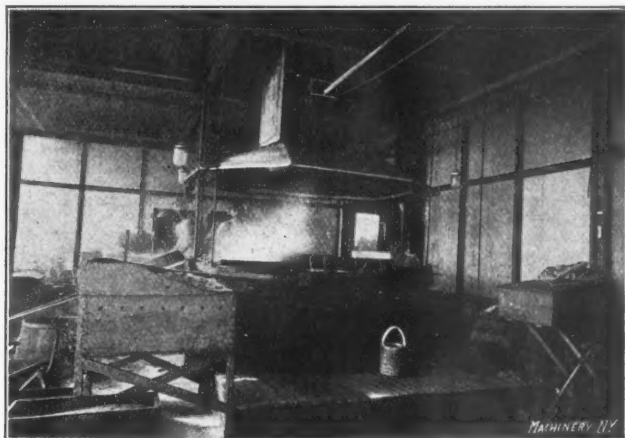
Fig. 23. Exhaust Fan and Hood over Acid Vat

gerous from spattered lubricant. Stock for immediate use is kept off of the floor by using the hook brackets shown in Fig. 13. Not only is this done for neatness and convenience, but also to prevent accidents caused by stepping on bars that are likely to roll.

All jigs used on milling machines and the like, are so arranged as to be drawn back and well away from the cutters

is shown the adjustable wheel covers and telescoping tubes used on the regular two-wheeled universal grinders, while in Fig. 17 is shown the method of piping a grinder with a swiveling head. Every wheel in this large department is thoroughly equipped and the air is as free from dust as in any other place. Fig. 18 is a surface grinder of the planer type, equipped with a wheel guard and a large suction funnel just back of the

wheel, that catches and carries off all the metal and emery.

In the polishing department, a splendid exhaust system is in use as shown in Fig. 19, and here even the overhead pulleys have the spokes covered in order to avoid the fan action as much as possible.

In the woodworking department, there are guards of all kinds to prevent accidents, and special devices are used to cover as much of the cutters as are not actually in use. Wooden jigs are used for holding various parts while machining them on shapers, saws, etc., in order not to get the hands too close to the tools. A number of these jigs and special guards are shown in Figs. 20 and 21. All dangerous parts or

Fig. 24. View showing Suction Openings in Plating Room

places in the wood shop are painted a bright red, belts and pulleys are boxed as in Fig. 22, and band-saws are covered as much as possible.

Acid and other fumes in the plating or lacquering rooms, are drawn off through hoods placed over the vats or tanks as in Fig. 23 or else by suction hoods at the back of the tanks as in Fig. 24, the powerful suction being shown by the way steam is drawn in from the tank next to the window.

The big potash tanks are equipped with mechanical dipping devices, so that the men will not get their hands into the biting stuff. This dipping machine is shown in Fig. 25. It consists of a series of cages or frames fastened by chains running over pulleys, to a reciprocating bar worked by a pulley and crank, in such a way that the cages dip up and down in
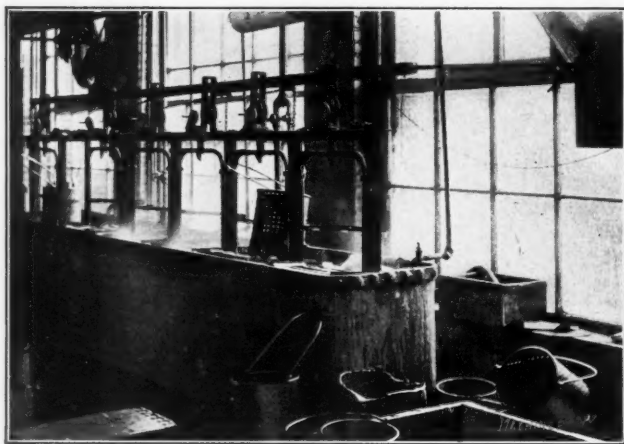
Fig. 25. Dipping Machine and Potash Tanks

the tank continually unless caught and held up by a hook or latch at the top of the framework. All but one of the frames are shown "hooked up" in the engraving. The perforated pails containing the oily parts, are placed in one of these cages and the hook pulled back; the cage then proceeds to automatically dip in and out of the potash until the operator again hooks it up. The parts are then allowed to drain awhile, after which they are removed from the bucket. Not only does this machine save the men's hands and bodies from the principal effect of the potash, but it also prevents the inhaling of the fumes that is the inevitable accompaniment of hand dipping. The machine is also a great time saver.

Going up the stairway from one floor to the other, one notices how even the stairs are railed and guarded with heavy wire screen as in Fig. 26, and in many places where trucks have to be run up long inclines, strips or belts of a cork-like material are laid in the floor to walk on and to prevent slipping and consequent injury.

While gathering material for this article, I was greatly assisted by Mr. Reeder, manager of the Welfare Department; Mr. Sager, machine supervisor; and Superintendent Oswald, and my thanks are especially due to the last-named gentleman, whose permission and kindly interest made possible this article.

* * *

JEWELERS' WAX

ARTHUR A. RACICOT*

To make jewelers' wax, take common rosin and heat it in a vessel until it flows freely; then add plaster of paris, stirring continually while adding the powder. Care should be taken not to make the mixture too stiff. When it appears of the proper consistency, pour some of it on a slate or marble slab and allow it to cool; then insert the point of a knife under the flattened cake thus formed and try to pry it off. If it springs off with a slight metallic ring, the proportions are right; if it is gummy and ductile, there is too much rosin; if it is too brittle and crumbles, this indicates that there is too much plaster.

This is what is sold for jewelers' cement at thirty cents for a half pound cake. It is used for filling gold headed canes, umbrella handles, cementing stones in ring settings, and also for holding very thin pieces of metal on a faceplate for drilling, cutting disks, or turning off the surface.

I gave this formula to a friend who had some

Fig. 26. Railed and Guarded Stairway

very artistic tile for a fire-place, and after having set as many as he could one evening, he forgot that the wax only needed rewarming in order to use it the next day, so in order to keep it fresh he poured water in the iron pot; in the morning the wax had become insoluble owing to the action of the water on the plaster. So it is advisable not to wet the wax until it is put to its final use and place.

* * *

Iron castings that are too hard to machine or which have hard spots destructive to tools may be nicely annealed by packing closely in covered cast iron boxes with black manganese, and heating to a temperature of 1,500 or 1,600 degrees F. until thoroughly heated through. A large box packed in this manner with a closely-fitted cover luted with fireclay must be heated for several hours to raise the interior to the annealing temperature. To be sure of getting the interior heated properly, a number of witness wires should be placed in the box, projecting through the cover where they can be conveniently grasped with tongs and pulled out one at a time to show how far the heat has progressed. When the interior has reached a bright red heat the box should be hauled out and covered with ashes so that it will cool slowly. It is claimed that hard spots in gray iron castings can be softened with black manganese by applying the manganese and heating to a dull red, using a blow-torch or any other convenient means of heating.

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ASSEMBLING A 48-INCH MOTOR-DRIVEN PLANER—2

ALFRED SPANGENBERG*

In the previous article it was stated that the principal points to be observed in planer erection are: housings parallel with each other and square with the bed; accurate fit of all sliding members and truth of all plane bearing surfaces; proper mesh and smooth working of gears; and a system that permits the various parts to be easily and quickly assembled, and avoids the necessity of fitting the members together for the laying-out operations. In the first article boring and drilling the bed, drilling the housings, and testing the housings were described, and in this, the concluding part, we will take up laying out the arch bars, assembling operations on the bed, setting the housings, assembling the driving, feed and arch members, laying out and setting the cross-rail and the final test and inspection.

Laying Out the Arch Members

The first drilling operation on the arch is for the housing bolts, the jig for this being shown at *C*, Fig. 4; then the arch
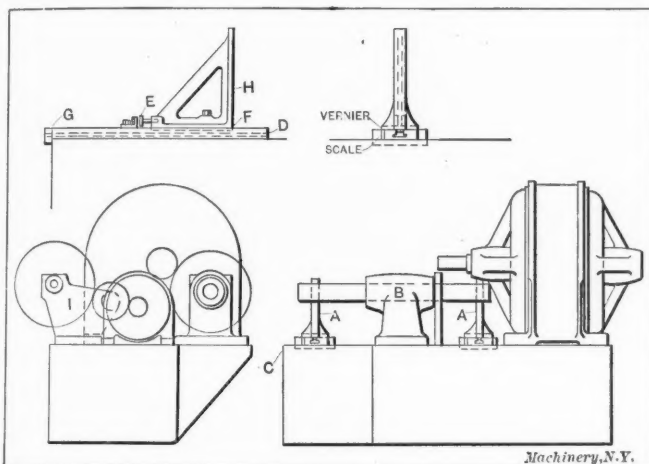

Fig. 8. Arch with Bracket Members and Motor in Position for Laying Out

is set under the drill in its normal position and the brackets and motors are located for marking off the bolt holes, as illustrated in Fig. 8. When these holes have been drilled and tapped, the arch members are bolted in place for drilling the dowel pin holes, this time more care being exercised in the setting. This is another instance where the varying character of the parts precludes the use of drill jigs, and a method of laying out the work must be resorted to. For convenience in obtaining accurate measurements, and to facilitate the work, a pair of adjustable angle-plates are used, as shown at *A*, the idea being to use an arbor in the bracket hole *B* and to provide a positive locating surface at each end, against which the arbor just touches.

The location endwise not being as particular, a line is scribed on the arch the correct distance from end *C*, and the bracket, with a scale held against the end, is set so that the edge of the scale coincides with the line just mentioned. As will be seen from the detail view, the angle-plate is adjustable on its base *D*, and may be turned end for end and clamped in any position as the case may require, fine adjustment being made by the screw *E*. Fastened to base-plate *D* is a scale, while attached to angle-plate *F* is a vernier, this combination enabling very accurate settings; all readings are taken from the lip *G* to surface *H*, and it is necessary, of course, to add half the diameter of the shaft to obtain the center distance. Bracket *I*, for the top elevating shaft, is set in the same manner, except that the angle-plates are reversed on account of the bracket being so close to the edge of the arch. With both brackets bolted fast and pinned, and their gears in place supported on short arbors, the motors are set so that their pinions mesh properly with the respective gears; then the motor clamping bolt holes are marked off, drilled and tapped, and the motors reset for pinning. In case the design is such that the entire top surface of the arch casting is not planed, *i. e.*, where finished seats are provided for the brackets and motors,

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additional spots are required for the angle plates. These spots are conveniently located on the casting and are finish planed with the other seats.

Assembling Operations on the Bed

The first assembling operations proper on the bed consist of drilling the various set-screw and oil pipe holes; drilling and fitting the track oiling device, a drill jig for which is shown in Fig. 9; and assembling the rack gear, its shaft, and the two intermediate compound gears and shafts. These operations, together with placing the housings on the bed, are done before the leveling operation, as otherwise the consequent hammering and additional weight of the housings might throw the bed out of level.

During erection, the bed is supported on cast iron parallel blocks placed about six feet apart along the whole length of the bed and also under the housings. Planed cast iron wedges, having screw adjustment, are placed between the parallel blocks and the bed, thus enabling very accurate leveling to be accomplished. The arrangement of all the blocking is such that none of it will interfere with the driving and feed mechanism during erection, and as these details vary in different machines, the blocking must be arranged to suit each machine.

Several methods may be followed in leveling a planer bed, any one of which will give good results if the work is carefully done. The prime requisites are, of course, a first-class, sensitive, spirit-level—one at least 18 inches long—and an accurate parallel that will reach across both tracks. It is obvious that since the tracks in a new bed are not worn, just as good results are obtained in leveling, by using the top surface on the tracks, as by using either V-shaped parallels or cylindrical pieces in the ways. The leveling is done as follows: The level is used on the top surface of one track, and that side of the bed is carefully leveled by moving the instrument short distances at a time, over the entire length. Then, by placing the level on the parallel, the bed is leveled crosswise; the operation of first leveling one side and then cross-leveling to the other is repeated several times, or at least until no further errors can be detected.

Setting the Housings

Fig. 10 is a top view of the planer, and shows the general method of setting the housings; the operation involves the
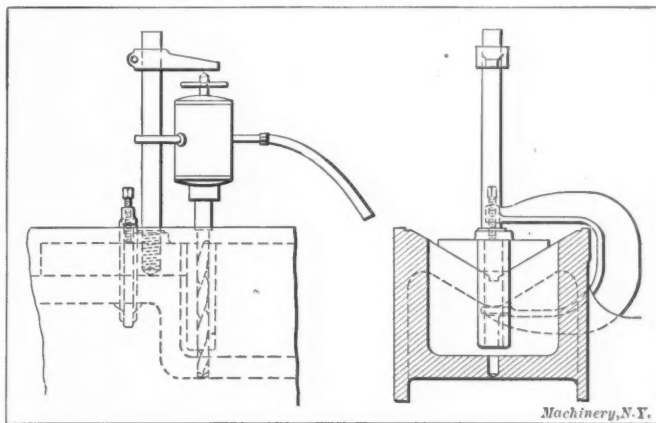
Fig. 9. Combination Drill Jig and "Old Man" for Drilling Hole in Oil Pockets for Oiling Device. Jig insures Hole being drilled in Center of Way

alignment of the driving shaft bearing in bracket *A* with that in the bed at *B*, and also includes bringing the faces of the housings into the same plane. With the housings bolted to the bed only sufficiently tight to hold them in place, and with driving shaft bracket *A* bolted and pinned fast to the front housing *C*, an arbor *D* is used as indicated. This arbor is ground true and is a wringing fit in the bed at *B*, and, being of smaller diameter where it passes through bracket *A*, permits it to be easily introduced into the bed bearing even though the bracket hole is out of alignment. This condition is possible, of course, since the clamping bolts *E* have $\frac{1}{8}$ inch clearance in the housings. Now, with bushing *F* in position to enter hole *G*, the front housing is driven with a babbitt hammer, either forward or backward as the case may require, until the bushing enters the hole freely without springing the arbor.

To set the back housing, a straightedge is laid across the bed as shown at *H*, and narrow strips of tissue paper are introduced at *I* and I_1; then, by moving the back housing until papers *I* are tight and I_1 can just be moved, it is determined that both housings are in proper alignment. The fact that the outside papers are slightly loose is due to conditions already stated. After reaming the housing dowel pin holes by means of an air drill, and driving in the pins, measurement is taken for arch casting *J*, and the housings are callipered over surfaces *K* just above the bed, and at the top, to test their parallelism.

While an attempt is made at interchangeability with respect to the length of the arch member, it sometimes happens that certain elements make it necessary to slightly deviate from the standard measurement. For instance, the above test may show the measurement over *K* to be from 0.002 to 0.003 inch wide or narrow at the top, in which case the housings are made parallel by means of a jack-screw, or tie-rod, as the case may require, and then the arch is machined to suit. The arch is now bolted in place, and set to match the housings at *L* and *M*, after which it is pinned.

Assembling the Driving, Feed and Arch Members

The cross-rail, side-saddles, and the various driving and feed units are assembled in a department separate from the erecting department, and these parts usually are duplicated in quantities and come from the store-room to the erectors completely finished. In all cases where possible in assembling these units, standardization is provided for, and in this way much time is saved by the erectors avoiding unnecessary adjustments.

Referring back to Fig. 1, the feed box *E* is next bolted in place, and after assembling the driving shaft *F* with its members, and bolting on the bracket member *G*, the outboard bearing *H* is bolted in position. The arch bearing for the fly-wheel shaft *I*, already being secured in place, this shaft is red-leaded and tried in its bearings to test their alignment. When proper care is exercised in the aligning operations, very little scraping is necessary on these bearings.

Fig. 10. Method of Setting the Housings. First the Front Housing is set for Alignment of Driving Shaft Bracket "A," then the Back Housing is brought into the Same Plane by means of Straightedge "H"
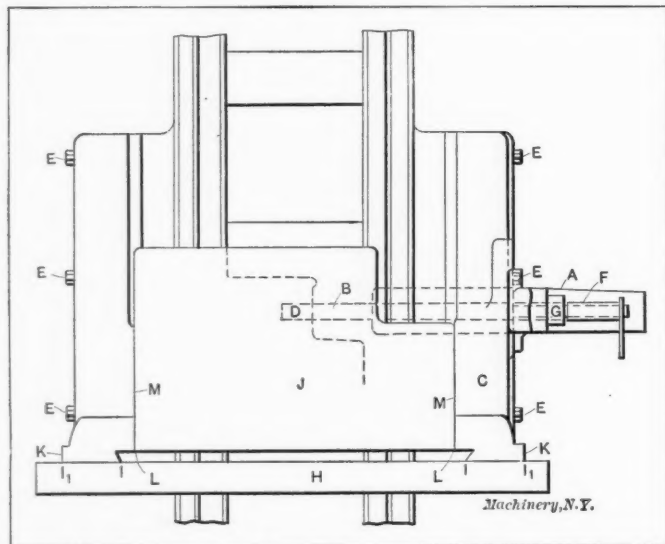
While work is proceeding in assembling the top works, elevating screws, and motors, other erectors are busy with the side-heads *D*, rocker mechanism *J*, and the feed mechanism for the side-heads and cross-rail; each unit is assembled in logical order, and as many operations as possible are carried on simultaneously. The planer is now ready for the cross-rail *K* and table *L*, preliminary work on these members being completed far enough ahead so as to cause no delay at this point.

The operations on the table consist of drilling and reaming the stop-pin holes, drilling and bolting on the rack, and rough scraping the tracks; the oil grooves were cut in the machining process. A large motor-driven multi-spindle drill is used for drilling and reaming the stop-pin holes. This machine carries sixteen spindles, arranged in two rows; one row of spindles carries the drills, and the other the combination mills and countersinks. After the first row of holes is drilled and the table is indexed along the space of one row, the combination mills and countersinks are inserted, and the sixteen tools are used simultaneously, thus producing very rapid work. The table is supported on a special truck running on a track between the drill uprights, and a suitable mechanism for moving and indexing the table completes the equipment. Previous to placing the table on the bed, the ways on the latter are also rough scraped, and then the bearing surfaces receive a coat of red lead which serves the double purpose of marking material and lubricant.

Laying Out and Setting the Cross-rail

The stud holes *A* for the cross-rail gibs are drilled in the manner shown in Fig. 5. As will be seen, spots are planed off at *B* which serve to square jigs *C* and C_1, and the holes for
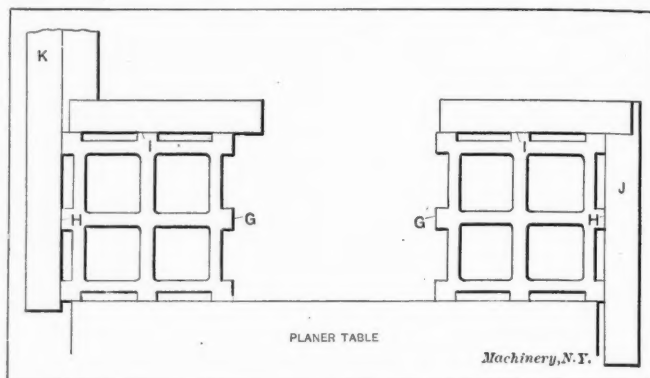
Fig. 11. Method of Testing Accuracy of "Planing Square" when using the Side-heads

the elevating screw nuts are utilized for clamping the jigs by means of bolts *D*. Endwise location of jig *C* is determined by matching the end of the cross-rail as shown; then jig C_1 is set by transferring the measurement from the housings by means of the wooden straightedge *E*. A flat scriber, shown at *F* and F_1, is used to mark lines on the straightedge which is chalked for this purpose, and when corresponding lines on the jigs coincide with those on the straightedge, jig C_1 is properly set.

When the studs are screwed in place and the back surface of the cross-rail is scraped, the cross-rail is placed in position on the planer and clamped by its gibs. Squaring the cross-rail with the housings is accomplished by holding the bar of a sweep in the angle *M*, Fig. 1, and applying an indicator to the front housing at *N* and N_1 (Fig. 1). The low end of the cross-rail is raised a sufficient amount by either moving the teeth in bevel gear *O* or O_1, as the case may require, in relation to its pinion, or by adjusting one of the nuts on the gear end of the elevating screws, final adjustment being obtained by the latter method. It is always better to raise the low end rather than lower the high end of the cross-rail, on account of the fact that this will take up any lost motion or backlash between the nuts, the feed-screws, and the housings. As the studs have 1/16 inch clearance in the gib, it is necessary to pin the latter after setting the cross-rail.

Final Test and Inspection

With the motors wired up, the belts in place, and the machine thoroughly oiled, the driving works are run for a while before moving the table into mesh with its rack gear, the idea being to prevent possible heating of the bearings by running without load. Next the table is brought into mesh and the bed is again carefully leveled in the same manner as before. When this is accomplished, the ways and tracks are scraped to a bearing, after which the ways are oiled and one or more cuts taken across the table to true it up for the purpose of testing the planer. A straightedge tried on the table crosswise, lengthwise, and across corners, is used to test the truth of the planing.

The side-heads are next tested for "planing square" by the method illustrated in Fig. 11. Two cast iron parallels *G* are clamped one on each side of the table as shown, and then light cuts are taken down faces *H* with tools in the side-heads.

Now, with the faces H clamped to the table, cuts are taken down faces I, after which the parallels are turned back to their original positions and a square tried as at J. To "prove" the square, it is used in connection with a straightedge (on the same parallel) as at K, any error detected between the blade of the square and the straightedge showing double the amount of actual error.

The accuracy of setting the cross-rail is now determined by taking a light cut across faces I, using a tool in one of the cross-rail heads, and testing with the square and straightedge as in the previous case. The object in making these tests is a precautionary measure, for by testing the planer under actual working conditions, the accuracy of the tests made during erection are thus proved.

Final inspection includes running the cross-rail to the top of the housings to test the elevating mechanism and ascertain the fact that there is clearance between the cross-rail and arch. All gearing is tested for quiet and smooth running; the fits of all bearing surfaces are inspected; the slides and saddles are run by hand to test the parallelism of their ways and also the ease with which the slides operate, after which the power feed is applied and tested in various ways; the balance of the driving motor armature, and of the fly-wheels and pulleys also, receives careful inspection; in fact, no part is neglected and all errors must be within allowable limits of variation. All tests are made under the personal supervision of an inspector, who enters all data on a form prepared for the purpose, and this report bears the serial number of the planer, and is filed away for future reference.

As opportunity offered during erection, the filling, rubbing down, and priming has progressed, so that after inspection, all that remains to be done is to give the bright parts their final polish, and apply the last coat of paint.

* * *

LONGITUDINAL JOINT FOR BOILERS*

It has been generally accepted in this country that the best form of butted longitudinal riveted joint for boilers is that in which the inside strap is wider than the outside, and has one or more rows of rivets which pass through the shell and the inside strap beyond each edge of the outside strap. The pitch of the first row of outer rivets is double that of the rows that pass through both straps, and if there are other outer rows they may or may not have a still greater pitch. In England, where, until comparatively recently, boiler construction has
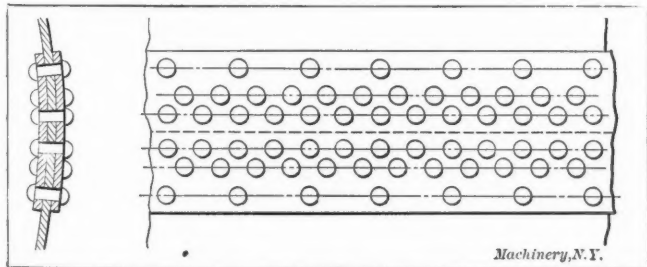
Recommended Type of Longitudinal Boiler Joint

been superior to ours, this form of joint appears· to receive no recognition. It was first devised, as far as known, by Dr. E. D. Leavitt and Edward Kendall, both of Cambridge, Mass., and was first used in 1879 by Mr. Leavitt in some locomotive-type boilers designed by him for the Calumet & Hecla Mining Co. It is, of course, hazardous to state that this joint was never used before, and it is quite possible that it was used in England and discarded.

While every boilermaker has for years been familiar with butt joints, this form made slow progress towards adoption in this country. One form of joint used to avoid the butt joint and get something as good was a lap joint with an inside strap bent at the edge of the lap and riveted on each side of it. This was used on locomotives exclusively, and was of little or no value, as it was simply a somewhat elastic bent tie connecting the two parts of the shell plate. Finally, and fortunately, this joint gave way to the butt joint first described. It has, however, been the author's opinion for some

* Abstract of a paper by Mr. F. W. Dean read before the American Society of Mechanical Engineers, December meeting, 1909.

years that a one-sided boiler joint, such as that first described, is also poor construction, and may sooner or later cause a crack in the plate. It is evident that unless the outside rivets fill the holes, they do very little good, and when they do fill them they form an overhung connection and to some extent possess, in themselves, the now recognized defect of the lap joint. Moreover the extended inside plate forms a bent connection between the different rivets at different distances from the center line of the joint.

In many cases designers have placed the outside rivets at a considerable distance from the edge of the outside strap, and this is constantly overdone. It is obvious, on careful thought, that the outside rivets should be as near the edge of the outside strap as practicable, thereby diminishing the bent-tie effect. In order to diminish this effect still further, and also to render the overhung rivets more effective, the inside strap should be thicker than usual, and this feature can hardly be overdone. The inside strap should be at least as thick as the shell plate, and great care should be taken to have the holes match and the rivets fill the holes.

When a joint of this kind is tested to destruction in a testing machine, it will be found to fail somewhat in detail, the inside strap bending slightly and the outside rivets being the last to rupture after yielding a little. In a boiler the joint would be weaker than a flat specimen on account of the bent-tie feature. This could be prevented if it were practicable to calk the inside strap as it would thereby be compelled to maintain the circular form. The theoretical efficiency of this joint is greater than of any other kind, but in practice the efficiency is not realized.

In order to avoid the defects of the one-sided butt joint, the author has adopted a joint with both straps of the same width, as illustrated in the accompanying engraving. This has the merit of having all rivets in double shear and the strains all taken care of in the best manner. The efficiency of this joint can hardly be above 84 or 85 per cent, while that of the one-sided joint can be theoretically 91 or 92 per cent; but the certainty that the efficiency of the former is realized in practice is ample compensation for the use of slightly thicker plates. The pitch of the outer rows of rivets is rather great, compelling the use of a thick outside strap in order to stand calking and remain steam-tight. An equally thick inside strap is used in order to diminish the bent-tie effect. This effect is small, however, as the rivets are all near the center of the joint. It can be eliminated by calking the inside strap, which is practicable with this joint, and is done in the best marine practice.

* * *

The manner in which samples of air at high altitudes are collected shows an interesting example of the methods employed by scientists for ascertaining facts which cannot be obtained by direct personal investigation. Samples of air at a height of nearly nine miles have recently been obtained and examined for the purpose of ascertaining the presence of rare gases. The collecting apparatus is carried by a large balloon and consists of a number of vacuum tubes, each drawn out to a very fine point at one end. At the desired height, an electro-magnetic device connected with each tube, and operated by a barometer, breaks off the point of the tube, thus admitting the air. Within a few moments a second contact sends current through a platinum wire around the broken end, thereby melting the glass and sealing the tube. The samples thus obtained have shown the presence of argon and neon, but no helium was found in air above an altitude of six miles.

* * *

High speed steel has made a great improvement possible in the speed of threading dies on bolt machines. At the Atlantic City conventions of the Master Mechanics and Master Car Builders' Associations, the Landis Machine Co. exhibited a bolt threader equipped with a Landis high speed die, working at a cutting speed of from 45 to 55 lineal feet per minute. Rough bolts were threaded with startling rapidity, a two-spindle machine keeping a man busily employed all the time when threading ⅝-inch bolts with, say, 1¼ inch of thread. The actual time required for cutting the thread of this size and length was only about three seconds.

SHOP PHOTOGRAPHY*

R. F. KIEFER†

The writer has read with interest several articles on shop photography which have, from time to time, appeared in MACHINERY. However, some of these articles disagree, to some extent, and are not as complete as they might have been. This prompts the writer to describe the methods used by him during a ten year's experience in the taking of pictures. When these methods are carefully followed, there is practically no excuse for failure or for poor pictures.

The Camera

For general shop work a double extension camera, equipped with rising, falling and sliding front, swing and reversible back, is recommended. It should be fitted with a level. A

fan can be placed in a ventilator and used as an exhaust fan. This is a satisfactory and economical arrangement. Cold, running water is essential, and hot water desirable, this latter because trays, graduates, etc., can be quickly washed with hot water, and will be perfectly clean, especially if a few drops of sulphuric acid be added to the water and the utensils left to soak a few minutes. They are then thoroughly rinsed with cold water. If this is frequently done, it will save many pictures which might otherwise be spotted, streaked or stained.

Halation

Halation, which spoils many otherwise good negatives, can be intelligently guarded against. The writer disagrees with a previous contributor who says that "negatives entirely free from halation are as easily and truly made upon glass plates

TABLE I. TIME OF EXPOSURE FOR DIFFERENT LIGHT FACTORS
Interiors; Dark-colored Objects

Lens Diaphragm		10 sec.	15 sec.	20 sec.	25 sec.	30 sec.	35 sec.	40 sec.	45 sec.	50 sec.	1 min.	1¼ min.	1½ min.	2 min.	2½ min.	3 min.	3½ min.	4 min.	5 min.	6 min.	8 min.	10 min.	12 min.	15 min.	20 min.	30 min.
F- 5*	2†	⅔	⅘	1¼	1½	1¾	2¼	2⅔	2½	3	3¾	4½	5	7½	8½	10	12	15	18	20	30	38	45	48	1½	1¾
F- 8	4	1⅕	1¾	2½	3	3¾	4½	4¾	5	6	7½	9	10	15	18	20	25	30	38	45	1	1¼	1½	1¾	2½	3¾
F-11	8	2¼	3¾	5	6¼	7½	9	9½	10	13	15	18	20	30	38	45	52	1	1¼	1½	2	2¼	3	3¾	5	7½
F-16	16	5	7½	10	12½	15	18	20	20	25	30	36	45	1	1¼	1½	1¾	2	2¼	3	4	5	6	7½	10	15
F-22	32	10	15	20	25	30	36	45	45	50	1	1¼	1½	2	2½	3	3½	4	5	6	8	10	12	15	20	30
F-32	64	20	30	45	52	1	1¼	1½	1½	1¾	2	2½	3	4	5	6	7	8	10	12	16	20	24	30	45	60
F-45	128	45	1	1½	1¾	2	2½	3	3	3½	4	5	6	8	10	12	14	16	20	24	32	40	48	60	90	120
F-64	256	1½	2	3	3½	4	5	6	6	7	8	10	12	16	20	24	28	32	40	48	60	80	96	120	180	240

* British system. † United States System.   Figures beneath heavy lines signify minutes; those above, seconds

small T-level, such as can be obtained for twenty-five cents, is preferable. The best size of camera is 5 × 7 inches. Anything larger is more or less cumbersome and heavy, and if pictures larger than 5 × 7 inches are required, it is a comparatively simple matter to enlarge them. On the other hand, cameras smaller than 5 × 7 inches are apt to require the enlarging of many pictures, and this, of course, would be too expensive. While the best lens is none too good, an anastigmat working at F 5.5 is as fast and good as ordinarily will be required. An automatic shutter is desirable. As regards plates, pictures can be taken rapidly on "fast" plates; the writer is now using a plate which requires only one-quarter to one-third the length of exposure required with the ordinary plate.

as upon films." This is true only if the glass plate is specified as "non-halation."

In photographs of interiors, the strongest high-lights, such as the windows, or the brilliant polished portions of machinery which in some cases reflect light sufficiently to cause the same results, are almost always blurred at the edges. This is due to halation, or reflection from the inner surface of the glass. When we consider the difference in thickness of a glass plate and film, we can readily understand why films show less halation than glass plates.

In order to overcome halation when using glass plates, it is necessary either to use non-halation plates, or, if they cannot be procured, exceptional care must be used when employing ordinary glass plates. The article in the engineering edi-

TABLE II. TIME OF EXPOSURE FOR DIFFERENT LIGHT FACTORS
Interiors; Objects of Average Colors

Lens Diaphragm		10 sec.	15 sec.	20 sec.	25 sec.	30 sec.	35 sec.	40 sec.	45 sec.	50 sec.	1 min.	1¼ min.	1½ min.	2 min.	2½ min.	3 min.	3½ min.	4 min.	5 min.	6 min.	8 min.	10 min.	12 min.	15 min.	20 min.	30 min.
F- 5	2	⅔	⅘	⅘	1	1⅛	1¼	1½	1¾	2	2⅖	3¼	3½	5	6¼	7½	9	10	13	15	20	26	30	36	48	1⅛
F- 8	4	9/16	1⅕	1¾	2	2⅖	3	3½	3¾	4	5	6¼	7½	10	12½	15	18	20	25	30	45	52	1	1⅕	1¾	2¼
F-11	8	1¾	2⅖	3¾	4¼	5	6	7½	7½	9	10	13	15	20	25	30	38	45	52	1	1¼	1¾	2	2¼	3¾	5
F-16	16	3¾	5	7½	9	10	13	15	15	18	20	25	30	45	52	1	1¼	1½	1¾	2	3	3½	4	5	7½	10
F-22	32	7½	10	15	18	20	25	30	30	40	45	50	1	1¼	1½	2	2½	3	3½	4	6	7	8	10	15	20
F-32	64	15	20	30	36	45	50	1	1	1¼	1½	1¾	2	3	3½	4	5	6	7	8	12	14	16	20	30	45
F-45	128	30	45	1	1¼	1½	1¾	2	2	2½	3	3½	4	6	7	8	10	12	14	16	24	28	32	45	60	90
F-64	256	1	1½	2	2½	3	3½	4	4	5	6	7	8	12	14	16	20	24	28	32	48	56	64	90	120	180

Figures beneath heavy lines signify minutes; those above, seconds.

The Dark-room

The dark-room is not usually given the consideration which it requires, and this is a fruitful cause of poor pictures. The dark-room should be of ample size to permit working without being cramped for room. It should have red or ruby light for ordinary dark-room work, and opportunity for daylight for printing. Good ventilation is also important, because it is just as difficult to do good work at an excessive temperature in the dark-room as anywhere else. An ordinary desk

tion of MACHINERY, January, 1909, entitled "Industrial Photography" gives some good hints in regard to the avoidance of halation when using glass plates. The covering up of windows, for instance, is there mentioned.

It might not be out of place to mention here that in few, if any, shops are the windows kept as clean as they might be, and this fact alone is often of advantage. This is the only place in photography where dirt in any shape is desirable. Even with dirty windows, however, a picture should not be taken with the camera pointing directly toward the light. If a machine, for instance, is placed on the east side of the building, and we must take our picture from the west side, the picture should not be taken in the morning but rather in the late afternoon, at which time the light will be strongest behind the camera, and a much better picture will result. Furthermore, if choice of time is possible, take the picture when

the light is the softest or most even, so that the harsh contrasts which are apt to give the soot and whitewashed effects, are avoided. A reasonably soft light, long exposure with small diaphragm, and careful development, will give much better results than strong light, short exposure, and large diaphragm.

The operation of placing the dry plates in the plate holders is usually spoken of as "loading" the holder. Attention should be called to the advisability of cleaning the plate at this time. A soft camel's hair brush should be kept for this purpose only, and all plates should be carefully dusted before closing the slide, so as to remove all particles of dust which would
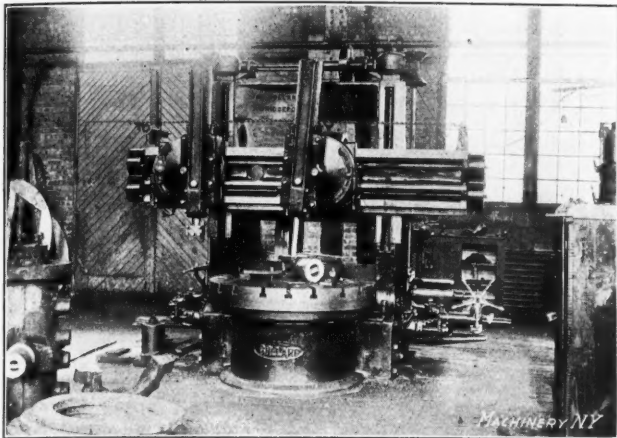

Fig. 1. Photograph taken 4.45 P. M. Diaphragm No. 32, Exposure 45 Seconds. Camera pointed toward the Light

cause spots in the finished picture. The plate holder as well as the slides should also be thoroughly dusted.

Focusing

In shop photography a different result is required than in portrait work, where "softness" is wanted. In machine photographs sharp lines are required. It is advisable to focus with the diaphragm set at No. 4, and after the image is as sharp and clear as possible, adjust to No. 16 or No. 32. This will give a much clearer picture and is well worth the extra length of exposure.

Exposure

A realization of the relation between the light, exposure and development, only comes to the photographer by experience and by a study of his prints. Correct exposure is only a relative term. Approximately correct is about as near as one can get to proper exposure in shop work. Experience and a certain amount of judgment enter into the decision as to the correct length of time. The exposure tables accompanying
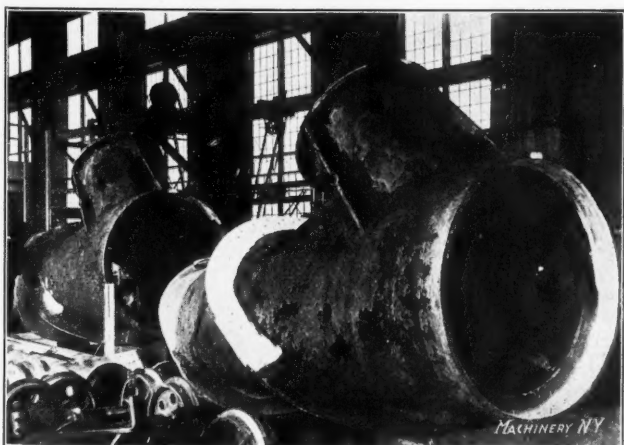

Fig. 2. Photograph taken 4.55 P. M. Diaphragm 64, Exposure 2 minutes. Camera not pointed directly toward the Light

this article will, therefore, be found convenient, and if the directions for their use, given in the following, are faithfully followed, very few pictures will be spoiled on account of improper exposure. It is, of course, desirable that the length of exposure be as near correct as possible, as this will tend to make the general average of the results better.

The method the writer uses in arriving at the decision in regard to the length of time for exposure is as follows: Take a fresh strip of standard "printing-out" paper—"Disco," manufactured by the Defender Photo Supply Co., "Solio," manufactured by the Eastman Co., or "Actinos," manufactured by the Lumiere N. A. Co.—and fold it over so that it covers itself in a way to expose only a small portion to the light. This paper should be kept covered until we are ready to take the photograph. Then hold the paper as nearly as possible where the average intensity of light strikes the machine. Uncover it and note the time required for discoloring the exposed portion of the paper so that it just presents a plainly discernible difference from the unexposed portion. This may require anywhere from two or three seconds to half an hour, depending, of course, upon the intensity of the light. In a medium light, from ten to forty seconds will suffice. This length of time is now our "time factor," and by referring to the accompanying exposure tables, it is easy to see what use is to be made of it.

The photograph shown in Fig. 1 was taken at 4.45 in the afternoon, and some halation can be noticed, but this can be overcome to a certain extent by printing the picture somewhat longer. In so doing, however, more or less detail will be lost. Solio paper was used to determine the light factor, which was forty-five seconds; diaphragm No. 32, U. S. system, was used. The machine photographed was painted with the ordinary black color of machine tools; therefore, the required length of exposure is found in Table 1, for dark-colored objects, in the column headed "45 seconds" and in the line denoted "F 22 Diaphragm 32" in the left-hand column. The required time of exposure thus is found to be forty-five seconds.

When the photograph, Fig. 2, was taken, "Disco" paper was used to determine the light factor, which in this case was one
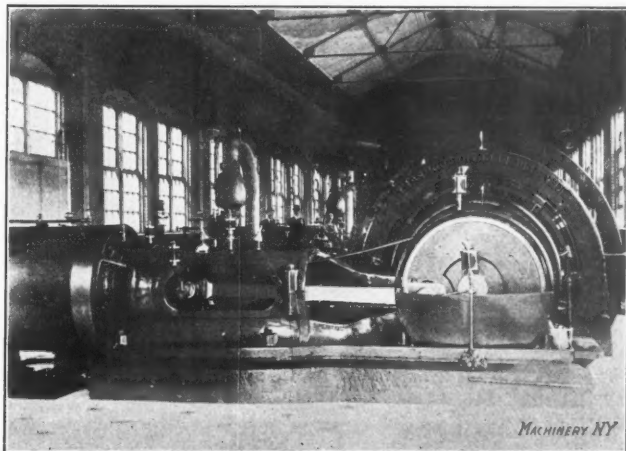
Fig. 3. A Picture taken on a Stormy Day, 11 A. M., with the Plate Reversed in the Holder, thus Reversing the Picture, but Avoiding Halation

minute. No. 64 diaphragm was used, and the length of the exposure was determined from the table in the same way as in Fig. 1, the time required being two minutes, as found in the vertical column headed "one minute" and in the horizontal line denoted "F 32 diaphragm 64." Comparing Figs. 1 and 2 a great difference is noticeable in regard to the tendency toward halation. Fig. 2 was exposed at 4.55 P. M., just ten minutes later than Fig. 1, both pictures being taken in the same shop on the same day. Fig. 1, however, was taken with the camera pointing directly toward the windows, while in Fig. 2 the windows are in a diagonal direction from the camera, this being the cause of the difference. In Fig. 2 the windows at the extreme left are very clear and distinct, while that toward the right, more nearly in front of the camera, shows a very distinct halation. This experiment proves conclusively the advantage of avoiding pointing the camera directly toward the light.

Fig. 3 was taken about eleven o'clock A. M., the sun shining very brightly. While this negative is fully timed there is practically no tendency toward halation. All these pictures were taken on plates. The reason that no halation is shown in Fig. 3, however, is disclosed by looking at the name-plate of the generator, which is reversed, or shows as it would in a mirror. This picture was taken "through the glass," that is, the plate was put into the plate-holder with the glass side out, which, of course, is the reverse of the usual method.

This, however, bears out the explanation of halation as being governed by the thickness of the glass plate. The same view taken two minutes later with the camera in the same place with the same length of exposure and the same diaphragm, but with the plate in the holder in the usual way was very badly affected by halation. A non-halation plate would, of course, in this case do away with the difficulty.

The exposure tables (Tables I and II) are intended for the following brands of plates and films: Ansco Film; Cramer Crown; Cramer Instantaneous Iso; Cramer Tri; Defender King Eastman Film; Eastman Extra Rapid; Forbes Instantaneous; Hammer; Kodoid; Lumiere Blue Label; Lumiere Ortho A; Lumiere Ortho B; Lumiere Panchro C; Lumiere Non-Halation Simplex Ortho A; Monarch; Pacific; Premo Film Pack; Record; R. O. C.; Seed 27; Standard Imp.; Standard Ex.

Lumiere New (Sigma) Σ and Lumiere Non-Halation Simplex (Sigma) Σ require but one-quarter the time specified in the tables.

Seed 26 x; Cramer Banner; Hammer Non-Halation; and Hammer Fast, require about one-half longer exposure than the tables call for.

Development

Assume that the plate has been exposed and that we are now back in the dark-room, ready to develop the plate. Before doing so, dust the plate again carefully with a camel's hair brush to remove any particles of dust that may have settled upon the plate when the slide was reversed after the exposure. Almost any developing agent will make a picture on a properly exposed negative, yet the writer has found it advisable to use a developer such as recommended by the manufacturer of the plate used. The development is a comparatively simple operation if undertaken in the proper manner. The most desirable color in a negative is a warm black, with possibly a slight tint of yellow through the image. The development should be carried only to the point where the highest lights are of a sufficient transparency to print details. This kind of negative prints quickly, and will be found the most satisfactory for printing on any class of paper. The temperature of the developer should never be allowed to rise above 70 degrees F. or fall below 65 degrees F. An all-glass dairy or bath thermometer, which can be purchased for about thirty cents, is very necessary for all dark-rooms. A too-cool developer produces thin negatives which have the appearance of being under-exposed. A too-warm developer, on the other hand, produces a heavy flat appearance in the negatives.

Table III, for which the writer is indebted to the M. A. Seed Dry Plate Co., gives the proportions of various developers. The numbers in the column headed "Factor" may require some explanation. The "factoral" system of development is a desirable one to use, exceedingly simple in its application, and insures the bringing out of everything that is in the negative. This system is based on the fact that no matter what the exposure, the development proceeds at the regular rate, and the time elapsing from the moment when the plate is placed in the developing solution until the appearance of the first high-lights of the image is a certain proportion of the total time required for the development. Suppose we are using Dianol developer, the factor of which is 18. The first high-lights appear twenty seconds after the plate has been placed in the solution. Then 18 × 20 seconds or 6 minutes total time is required for the complete development. When developed, the plate is removed from the developer, rinsed in fresh water and placed in the fixing bath.

A number of formulas for other common developing solutions with their factors are given below:

Pyro—Developing Factor 12

A. Pure water, 16 oz.; pyro, 1 oz.; oxalic acid, 10 gr.
B. Pure water, 16 oz.; sulphite of soda, 2 oz.
C. Pure water, 16 oz.; carbonate of soda, 2 oz.

To make the developing solution, use one ounce each of the solutions A, B and C, and add seven ounces pure water.

Eikonogen Hydrochinon—Developing Factor 12

A. Pure water, 48 oz.; sulphite of soda, 2 oz.; eikonogen, 240 gr.; hydrochinon, 60 gr.

(For more contrast, the quantity of water in the solution may be reduced to 32 ounces. Use boiling water. In cold weather a little glycerine will prevent precipitation.)

B. Pure water, 16 oz.; carbonate of soda, 2 oz.

To make the developing solution, use three ounces of solution A and one ounce of solution B.

Metol-hydrochinon—Developing Factor 15

A. Pure water, 64 oz.; metol, 120 gr.; hydrochinon, 120 gr.; sulphite of soda, 2 oz.

(Dissolve in the order given. Metol, to prevent precipitation, should always be dissolved in water before the sulphite is added.)

B. Pure water, 16 oz.; carbonate of soda, 2 oz.

TABLE III. DEVELOPERS WITH VARIOUS AGENTS

	A			B			Use			Factor
	Pure Water	Seed's Sulphite	Developing Agent	Pure Water	Seed's Carbonate	Potassium Bromide	A	B	Pure Water	
	oz.	oz.	gr.	oz.	oz.	gr.	oz.	oz.	oz.	
Metol*	16	1	120	8	1	..	4	1	5	25
Eikonogen	24	1	150	16	1	..	3	1	..	10
Hydrochinon**	16	1	160	16	2	80	1	1	..	4
Edinol	16	2	80	8	1	..	2	1	..	12
Tolidol	16	1	160	16	1	..	1	1	2	7
Glycin**	32	1	320	48	6	..	2	3	..	8
Imogen	16	1	240	24	3	..	2	3	..	7
Dianol	32	½	40							18
Amidol	24	½	40	No alkali needed					..	30
Rodinal			To ¼ oz. add 10 oz. water						..	30

* Dissolve metol in water before adding sulphite.
** For hydrochinon and glycin use potassium carbonate and dissolve glycin in hot water. Hydrochinon is a contrast formula for over-exposed plates and for black and white line work. It is not suitable for ordinary use.

If crystal sodas are used, add 15 grains of bromide of potassium to 16 ounces of solution B.

To make the developing solution, use four ounces of solution A, one ounce of solution B, and four ounces of pure water.

Acid Fixing Bath

A. Pure water, 96 oz.; hypo, 2 pounds; C. P. sulphite of soda, 2 oz.

B. Pure water, 32 oz.; chrome alum, 2 oz.; C. P. sulphuric acid, ¼ oz.

See that the chemicals are entirely dissolved, and then pour solution B into A slowly while stirring A rapidly.

Clearing Solution for Pyro Stains

Iron sulphate, 3 oz.; water, 16 oz.; sulphuric acid, ¼ oz.; alum, 1 oz.

Fixing

The fixing of a plate after development is so simple a matter that it is hardly necessary to more than advise the use of an acid-hypo fixing solution for plates, especially in the summer time, in place of the ordinary plain fixing bath. The plates should remain in the hypo bath for ten minutes after all white has dissolved from the reverse side of the negative. Then it should be well washed, say for one hour, preferably in running water.

Before allowing the plates to dry, the film side should be gently and carefully wiped with a wad of absorbent cotton to remove any "specks" which may be on the negative. This is very important, particularly when the water is very hard, as the film side collects a sediment when having been washed for some time, and if it is not removed before the negative is dry, it makes it unfit for printing. After having wiped the surface of the plate, rinse it thoroughly, and set it to dry in a ventilated place free from dust.

Negatives, when drying, should always be so placed that a current of air can pass around, over, and between them. The warmer this current of air is, the more intense the negative will be, and *vice versa*. Never change the location or position of a negative during the time it is drying, as marks and spots are almost sure to appear, owing to the fact that different conditions of air produce a difference in the intensity of the negative.

HARDENING CARBON STEELS*

H. RALPH BADGER†

Originally the name steel was applied to various combinations of iron and carbon, there being present, together with these, as impurities, small proportions of silicon and manganese. At the present time, however, the use of the name is extended to cover combinations of iron with tungsten, vanadium, nickel, chromium, molybdenum, titanium and some of the rarer elements. These latter combinations are quite generally known as the *alloy* steels to distinguish them from the *carbon* steels, in which latter the characteristic properties are
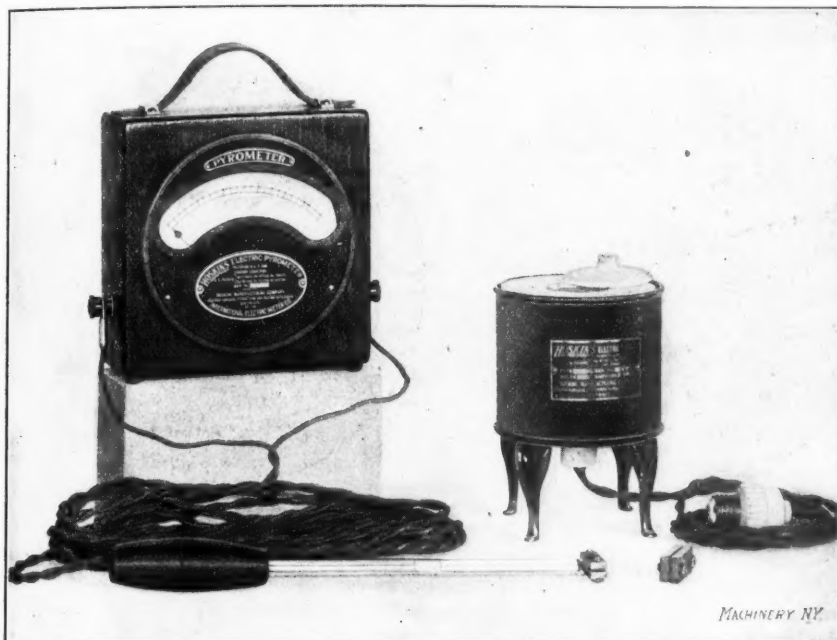

Fig. 1. Hoskins Electric Heating Furnace and Pyrometer used for ascertaining the Decalescence and Recalescence Points of Steel

dependent upon the presence of carbon alone. The alloy steels are divided into the high-speed steels and the Mushet or air-hardening steels. The specific properties that distinguish these different steels are due in part to their respective compositions, that is, to the particular elements they contain, and, in part, to their subsequent working and heat treatment.

Effect of Difference in Composition of Steel

In general, any change in the composition of a steel results in some change in its properties. For example, the addition of certain metallic elements to a carbon steel causes, in the alloy steel thus formed, a change in position of the proper hardening temperature point. Tungsten or manganese tend to lower this point, boron and vanadium to raise it; the amount of the change is practically proportional to the amount of the element added. Just as a small proportion of carbon added to iron produces steel which has decidedly different properties than those found in pure iron, so increasing the proportion of carbon in the steel thus formed, within certain limits, causes a variation in the degree in which these properties manifest themselves. For example, consider the property of tensile strength. In a "ten-point" carbon steel (one in which there is present but 0.1 per cent of carbon) the tensile strength is very nearly 25 per cent greater than that of pure iron. Adding more carbon causes the tensile strength to rise, approximately, at the rate of 2.5 per cent for each .0.01 per cent of carbon added.

Carbon steels are divided into three classes according to the proportion of carbon which they contain. The first of

these embraces the "unsaturated" steels, in which the carbon content is lower than 0.89 per cent; the second, the "saturated" steels, in which the proportion of carbon is exactly 0.89 per cent; and, the third, the "supersaturated" steels, in which the carbon content is higher than 0.89 per cent.

Effect of Heat Treatment

With a steel of a given composition, proper heat treatments may be applied which, of themselves, will first alter in form or degree some of its specific properties, or second, practically eliminate one or more of these, or third, add certain new ones. Physical properties of size, shape and ductility are examples of the first case; an example of the second case is found in the heating of steel beyond its hardening temperature, which takes away its magnetism, making it non-magnetic; and an example if the third case is the fact that a greater degree of hardness may be added to steel by the process of hardening. In this connection it must be understood that, strictly speaking, hardness is a relative term and all steel has some hardness.

There are three general heat treatment operations, so considered; forging, hardening—with which this article will deal—and tempering. In all of these the object sought is to change in some manner the existing properties of the steel; in other words, to produce in it certain permanent conditions.

The controlling factor in all heat treatment is temperature. Whether the operation is forging, hardening or tempering, there is for any certain steel and particular use thereof a definite temperature point that alone gives the best results in working it. Insufficient temperatures do not produce the results sought. Excessive temperatures, either through ignorance of what the correct point is, or through inability to tell when it exists, cause "burned" steel; this is a common failing, resulting in great loss. Very slight variations from the proper temperature may do irreparable damage.

Due to temperature variation alone, carbon steel may be had in any of three conditions: first, in the unhardened or annealed state, when not heated to temperatures above 1,350
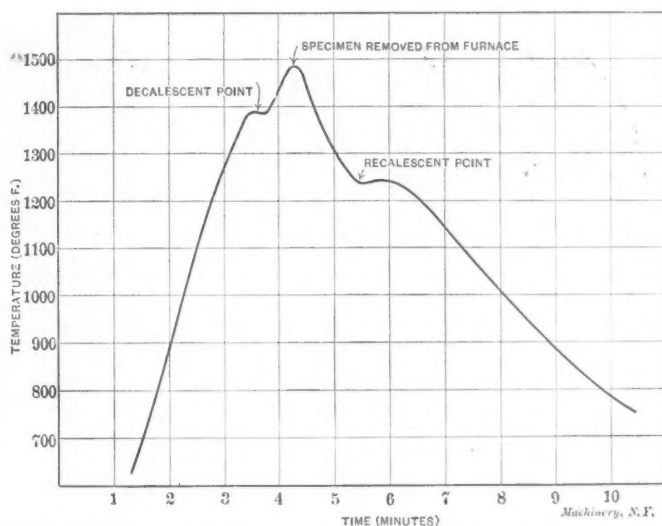
Fig. 2. Diagram showing the Relation between Time and Temperature when heating Steel, and the Critical Temperatures of One-point Carbon Steel

degrees F.; second, in the hardened state, by heating to temperatures between 1,350 and 1,500 degrees F.; third, in a state softer than the second though harder than the first, when heated to temperatures which exceed 1,500 degrees F.

The Hardening Process

The hardening of a carbon steel is the result of a change of internal structure which takes place in the steel when heated properly to a correct temperature. In the different carbon steels this change, for practical purposes, is effective only in those in which the proportion of carbon is between 0.2 per

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cent and 2.0 per cent, that is, between "twenty-point" and "two" carbon steels, respectively.

When heated, ordinary carbon steels begin to soften at about 390 degrees F. and continue to soften throughout a range of 310 degrees F. At the point 700 degrees F. practically all of the hardness has disappeared. "Red hardness" in a steel is a property which enables it to remain hard at red heat. In a high-speed steel this property is of the first importance, 1,020 degrees F. being a minimum temperature at which softening may begin. This is some 630 degrees F. above the point at which softening commences in ordinary carbon steels.

The process of hardening a steel is best carried out in a closed furnace. Of the many sources of energy capable of

heating causes irregular grain and internal strains, and may even produce surface cracks. Any temperature above the "critical point" of steel tends to open its grain—to make it coarse and to diminish its strength—though such a temperature may not be sufficient to lessen appreciably its hardness.

Critical Temperatures

The temperatures at which take place the previously mentioned internal changes in the structure of a steel are frequently spoken of as the "critical points." These are different in steels of different carbon contents. The higher the percentage of carbon present, the lower the temperature required to produce the internal change. In other words, the critical points of a high carbon steel are lower than those of a low carbon steel. In steels of the commonly used carbon con-

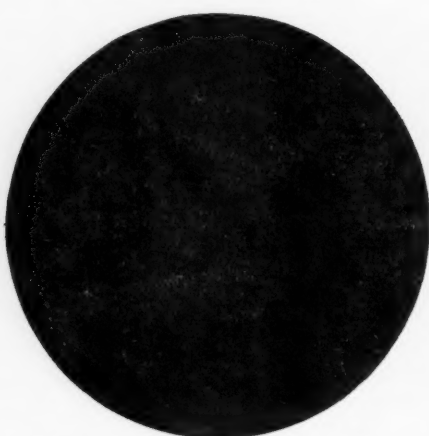Fig. 3. Micro-photograph (magnified 45 Diameters) of Steel Quenched at 1900 Degrees F.   Fig. 4. Micro-photograph (Magnified 45 Diameters) of Steel Quenched at 1750 Degrees F.   Fig. 5. Micro-photograph (Magnified 45 Diameters) of Steel Quenched at 1600 Degrees F.
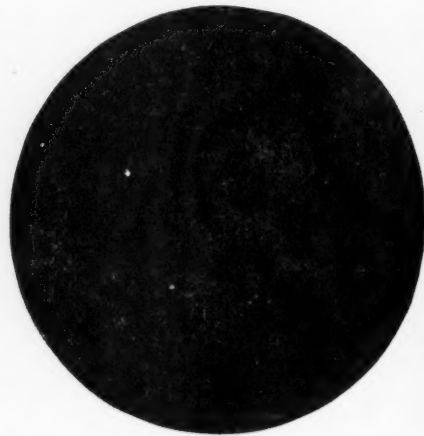
producing the required heat, electricity offers the most attractive advantages. The electric resistance furnace, as now built in a variety of sizes of either muffle or tube chamber types, has one fundamental point of superiority over all coal, coke, gas, or oil-heated furnaces. It is entirely free from all products of combustion, the heat being produced by electrical resistance. This is important. It does away with the chief cause of oxidation of the heated steel. Further, the temperature of the electric furnaces can be easily and accurately regulated to, and maintained uniform at, any desired point. When electric power is generated for other purposes, the in-

tents, there are two of these critical temperatures, called the *decalescence* point and the *recalescence* point, respectively.

The decalescence point of any steel marks the correct hardening temperature of that particular steel. It occurs while the temperature of the steel is rising. The piece is ready to be removed from the source of heat directly after it has been heated uniformly to this temperature, for then the structural change necessary to produce hardness has been completed. Heating the piece slightly more may be desirable for either or both of the two following reasons. First, in case the piece has been heated too quickly, that is, not uniformly, this excess

Fig. 6. Micro-photograph (Magnified 45 Diameters) of Steel Quenched at 1510 Degrees F.   Fig. 7. Micro-photograph (Magnified 45 Diameters) of Steel Quenched at 1425 Degrees F.   Fig. 8. Micro-photograph (Magnified 22 Diameters) of Steel Quenched at 1385 Degrees F., or 5 Degrees above the Decalescence Point
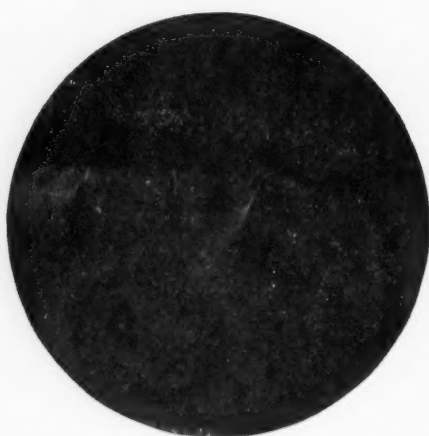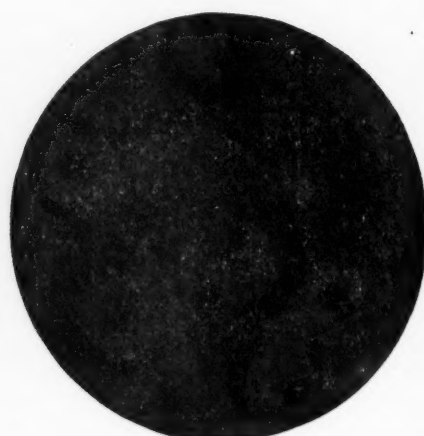
creased cost of this form of energy for operating furnaces is not sufficient to argue against it. Even when the current is purchased, the superior quality of work performed by this kind of furnace frequently more than offsets the slightly higher cost of operation.

In the actual heating of a piece of steel, several requirements are essential to good hardening: first, that small projections or cutting edges are not heated more rapidly than is the body of the piece, that is, that all parts are heated at the same rate, and second, that all parts are heated to the same temperature. These conditions are facilitated by slow heating, especially when the heated piece is large. A uniform heat, as low in temperature as will give the required hardness, produces the best product. Lack of uniformity in

temperature will assure the structural change being complete throughout the piece. Second, any slight loss of heat which may take place in transferring the piece from the furnace to the quenching bath may thus be allowed for, leaving the piece at the proper temperature when quenched.

If a piece of steel which has been heated above its decalescence point be allowed to cool slowly, it will pass through a structural change, the reverse of that which takes place on a rising temperature. The point at which this takes place is the recalescence point and is lower than the rising critical temperature by some 85 to 215 degrees. The location of these points is made evident by the fact that while passing through them the temperature of the steel remains stationary for an appreciable length of time. It is well to observe that the lower of

these points does not manifest itself unless the higher one has been first fully passed. As these critical points are different for different steels, they cannot be definitely known for any particular steel without an actual determination. While heating a piece of steel to its correct hardening temperature produces a change in its structure which makes possible an increase in its hardness, this condition is only temporary unless the piece is quenched.

Quenching

The quenching consists in plunging the heated steel into a bath, cooling it quickly. By this operation the structural change seems to be "trapped" and permanently set. Were it possible to make this cooling instantaneous and uniform throughout the piece, it would be perfectly and symmetrically hardened. This condition cannot, however, be realized, as the rate of cooling is affected both by the size and shape of the treated piece; the bulkier the piece, the larger the amount

Fig. 9. Micro-photograph of Steel Quenched at 1380 Degrees F. or when just reaching the Decalescence Point

of heat that must be transferred to the surface and there dissipated through the cooling bath; the smaller the exposed surface in comparison with the bulk, the longer will be the time required for cooling. Remembering that the cooling should be as quickly accomplished as possible, the bath should be amply large to dissipate the heat rapidly and uniformly. Too small a quenching bath will cause much loss, due to the resulting irregular and slow cooling. To insure uniformly quenched products, the temperature of the bath should be kept constant, so that successive pieces immersed in it will be acted upon by the same quenching temperature. Running water is a satisfactory means of producing this condition.

The composition of the quenching bath may vary for different purposes, water, oil or brine being used. Greater hardness is obtained from quenching, at the same temperature, in salt brine and less in oil, than is obtained by quenching in water. This is due to a difference in the heat-dissipating power possessed by these substances. Quenching thin and complicated pieces in salt brine is unsafe as there is danger of the piece cracking, due to the extreme suddenness of cooling thus produced.

In actual shop work the steel to be hardened is generally of a variety of sizes, shapes and compositions. To obtain uniformity both of heating and of cooling, as well as the correct limiting temperature, the peculiarities of each piece must be given consideration in accordance with the points outlined above. In other words, to harden all pieces in a manner best adapted to but one piece would result in inferior quality and possible loss of all except this one. Each different piece must be treated individually in a way calculated to bring out the best results from it.

Theory of Critical Points

The presence of the critical points in the heating and cooling of a piece of steel is a phenomenon. The most reasonable explanation is as follows:

While heating, the steel uniformly absorbs heat. Up to the decalescence point all of the energy of this heat is exerted in raising the temperature of the piece. At this point, the heat taken on by the steel is expended, not in raising the temperature of the piece, but in work which produces the internal changes here taking place between the carbon and the iron. Hence, when the heat added is used in this manner, the temperature of the piece, having nothing to increase it, remains stationary, or, owing to surface radiation, may even fall slightly. After the change is complete, the added heat is

again expended in raising the temperature of the piece, which increases proportionally.

When the piece has been heated above the decalescence point and allowed to cool slowly, the process is reversed. Heat is then radiated from the piece. Until the recalescence point is reached, the temperature falls uniformly. Here the internal relation of the carbon and iron is transformed to its original condition, the work required to do this being converted into heat. This heat, set free in the steel, supplies, for the moment, the equivalent of that being radiated from the surface, and the temperature of the piece ceases falling and remains stationary. Should the heat resulting from the internal changes be greater than that of surface radiation, the resulting temperature of the piece will not only cease falling but will obviously rise slightly at this point. In either event the condition exists only momentarily, but when the carbon and iron constituents have resumed their original relation, the internal heating ceases, and the temperature of the piece falls steadily, due to surface radiation.

Apparatus for Determining the Critical Point

From the foregoing sections it is evident, first, that there is a definite temperature at which any carbon steel should be hardened, and, second, that there results great loss, both of labor and material, unless the hardening is carried out at this temperature. The actual shop problem thus presented is to determine readily and accurately the correct hardening temperature for any carbon steel that may be in use. This can be done by the use of various types of pyrometers; the apparatus illustrated in Fig. 1, which is made by the Hoskins Mfg. Co., of Detroit, Mich., is well adapted for the purpose. This apparatus consists of a small electric furnace in which to heat a specimen of the steel to be tested, and a special thermo-couple pyrometer for indicating the temperature of this specimen throughout its range of heating. The specimen itself should be properly shaped for clamping to the thermo-couple.

The furnace may be operated on either alternating or direct current circuits. The furnace chamber is 2 1/16 inches in diameter and 2½ inches deep. Heat is produced by means of the resistance offered to the passage of an electric current through the "resistor" or heating element which in the form of wire is wound in close contact with the chamber lining. The furnace is designed so that it can be used on standard lighting circuits to which ready connection is made with a twin conductor cord and lamp plug. In operation, it consumes 3½ amperes at 110 volts, and is capable of producing a chamber temperature of 1,830 degrees F., which is considerably higher than required for a carbon steel.

The pyrometer consists of a thermo-couple, connecting leads and indicating meter. The thermo-couple is of small wire so as to respond quickly to any slight variation in temperature. The welded end of this couple is slightly flattened to enable a good contact between it and the steel specimen. The meter is portable and indicates temperatures up to 2,552 degrees F.

The specimen of the steel to be tested should be small, so as to heat quickly and uniformly. A well-formed specimen is made with two duplicate parts, each 1¼ inch long x ½ inch wide x ¼ inch thick. The pieces are clamped by means of two ⅛-inch bolts, one on each side of the welded part of the extreme end of the thermo-couple. Care is taken to form a tight contact, though not to cause an undue strain on the couple. The dimensions here given for the test specimen are not essential, though convenient; any pieces which will permit of tight contact with the thermo-couple and of readily heating in furnace chamber, may be used.

With the specimen fastened to the couple as just described, the furnace is connected in circuit and the cover placed over the chamber opening. The temperature within the chamber rises steadily. When it becomes 1,700 degrees F. the end of the couple, with specimen attached, is inserted in the chamber. The steel specimen rapidly heats, its temperature being constantly the same as that of the welded junction of the thermo-couple, due to the intimate contact between them. This temperature, indicated by the meter, will rise uniformly until the decalescence point of the steel tested is reached. At

this temperature the indicating needle of the meter becomes stationary, the added heat being consumed by internal changes. These changes completed, the temperature again rises, the length of the elapsed period of time depending upon the speed of heating. With the furnace temperature kept nearly constant at the initial point, here given as 1,700 degrees F., this "speed of heating" will be such as to allow of readily observing the pause in motion of the needle. The temperature at which this occurs should be carefully noted.

To obtain the lower critical point, the temperature of the piece is first raised above the decalescence point by about 105 degrees F. In this condition it is removed from the furnace and rested on top to cool. The decrease of temperature is at once noticeable by the fall of the meter needle. At a temperature somewhat below the decalescence point, varying with the composition of the steel, as previously mentioned, there is again a noticeable lag in the movement of the needle. The temperature at which the movement ceases entirely is the recalescence point. Immediately following there may occur a slight rising movement of the needle, as previously explained.

During these intervals of temperature lag, both during the heating and cooling of the steel, there may occur a small fluctuation' in the temperature. In order to get results that are comparable, a definite point in each of these intervals should be considered each time a test is made. Hence, both the decalescence and recalescence temperatures are taken as the points at which the needle first becomes stationary. As all operations of heat treatment of a steel center around its critical point, the importance of knowing these exactly is realized; to make certain, each test should be checked by a second reading. The time required for this is small. A close agreement of two succeeding readings will give assurance of the correctness of the determination.

Results Obtained from Sample Specimens

In order to show graphically the necessity of working carbon steels at the proper temperature points, a series of specimen pieces of the same steel were treated at different temperatures. The steel used contained exactly 1 per cent carbon, that is, it was a "one-point" steel. A number of test specimens were made of this from adjacent parts of the same bar.

First the critical points of this steel were determined. Temperatures were recorded throughout both the heating and cooling. In the diagram, Fig. 2, these values have been plotted. The curve shows grapically the location of the critical points, and also the slight fall or rise of temperature, as the case may be.

With this data obtained, seven specimens of the same steel were heated, in the electric furnace, each to a different temperature. As these pieces were removed from the furnace they were immediately quenched in water. The temperature of the quenching bath was held constant at 45 degrees F. The hardened pieces were then broken at right angles and the fractured surface of each was photographed under a microscope. These photographs are reproduced in Figs. 3 to 9 in the same size as the originals. Due to magnification, the first five of these engravings represent a circular area, the actual diameter of which is but 0.05 inch; while the piece illustrated in Fig. 8 is of 0.1 inch diameter.

An inspection of these shows at once the serious effects on its structure, and hence on its strength, of overheating a piece of steel. The micro-photograph of specimen No. 1, Fig. 3, shows a very badly "burned" steel, as is evidenced by the extreme coarseness of its grain. Specimen No. 2, Fig. 4, hardened at 150 degrees F. lower temperature, shows less coarseness, but is still badly "burned." The succeeding specimens, Figs. 5, 6 and 7, show a gradual improvement, as the temperature at which they were hardened approaches the decalescence point of the steel. Specimen No. 6, Fig. 8, was quenched just after the hardening change in its structure had become complete, at 5 degrees F. above the critical temperature. The very fine grain and closely woven texture of this fracture show a properly hardened steel, one which has both the desired hardness and the maximum tensile strength.

Specimen No. 7, Fig. 9, was hardened just as the temperature reached the decalescence point. This shows clearly the direction in which the hardening moves, namely, from the exterior toward the interior. This would naturally be expected as the temperature of the surface, which is exposed directly to the source of heat, reaches the critical point first. This illustration shows that the structural change has been completed only in the surface layer of the specimen. Here the grain is fine and the steel hardened, while the interior is still in the unhardened state. This condition indicates the necessity of heating the piece uniformly.

While 1,900 degrees F., the temperature at which the Specimen No. 1, Fig. 3, was hardened, represents, of course, a very excessive heat, yet it is not infrequent that carefully machined parts are ruined by overheating even to this degree. The practice of guessing at hardening temperatures can only result in uncertainty.

Conclusions

The hardening of carbon steels for highest quality and greatest saving entails, then, three things. First, a definite knowledge of what constitutes the correct temperature at which to harden the steel. The second point necessitates a positive means of accurately determining this hardening temperature for any carbon steel. The third consideration is that the correct hardening temperature, once determined, is actually carried out in the hardening work. A simple and effective way of doing this is by checking the temperature of the hardening furnace by means of a pyrometer. When there is a large quantity of work to be hardened, economy dictates a permanent installation of pyrometers. The convenience of such installations is manifest. A thermo-couple is placed in each furnace. A number of these, from three to sixteen, depending upon individual conditions, are connected by wire leads, through a selective switch to one meter. By a turn of the switch, the temperature of any furnace may be read at once from the meter. This makes it possible for the foreman to know definitely, at a single point, the temperatures of all of the hardening furnaces in use.

* * *

An aerial exhibition was opened in the Grand Palais, Paris, the last Saturday in September. Some thirty full-sized aeroplanes were exhibited in addition to a dirigible airship and several balloons. There was a striking likeness between all the heavier-than-air machines exhibited. Of course, two types were represented, the mono- and the bi-plane, but the Bleriot machine is the obvious prototype of nearly all the monoplanes, while all the biplanes show important features of either the Wright, Farman or Voisen branches of the biplane family. There were considerably more monoplanes than biplanes displayed, possibly because of the success of Bleriot's cross-channel trip, and, perhaps, also on account of the greater simplicity and cheapness of construction. Improvements are noted in the monoplanes, but no noteworthy improvements are visible over the already tested types of the biplanes.

* * *

The importance that engineering will play in the future in the destruction of harmful insects is, to some extent, indicated by the experiments which have been carried out with great success at Zittau, Germany. According to the *Scientific American*, the beam from a searchlight mounted on the roof of the municipal electric light plant was played upon a forest several miles distant, and the moths to be destroyed came fluttering up the beam in swarms to the light, behind which was the intake of a powerful suction blower. The moths were drawn in by the suction and exhausted into a wire net cage which was removed as often as filled. In one single night 140 pounds of moths representing, by numbers, some 400,000 were destroyed in this way.

* * *

A treaty has been made between the United States and Canada limiting the total amount of water that may be taken for power purposes at Niagara Falls. According to this treaty the power companies on the Canadian side are limited to 36,000 cubic feet per second, and those on the American side to 20,000 cubic feet. The average total discharge of the Niagara river is 250,000 cubic feet per second.

SOME INTERESTING CAM CONSTRUCTIONS*

EDWARD PERSON†

When designing automatic machines that are more or less complicated, it is not always possible to avoid the use of cams in order to accomplish the work for which the machine is intended. When several cams are to be used on the same machine, it is necessary to make up a cam chart from which the designer works when laying out the cams. This chart should give the stroke required for the mechanism and indicate what part of the revolution of the cam shaft is required to produce the required stroke, as well as the period of rest. These quantities are given in degrees.

Fig. 1 shows a cam chart for two cams, the curves being crank-motion curves. The first cam, starting at zero, moves the mechanism operated three inches, while turning 90 degrees. There is then a rest or dwell for 180 degrees, and a return movement in the remaining 90 degrees. The mech-

the points of the curve. It is of importance that these curves be correctly constructed, as this provides for a smooth movement of the mechanism at any point during the revolution of the cam. Of course, these curves do not need to be crank-motion curves, but can be changed to suit conditions.

Figs. 2 and 3 show the constructions of cams laid out from the first cam chart curve in Fig. 1. These cams are working positively in either direction. The construction in Fig. 2 consists of a grooved cam A, and a yoke B forked over the hub of the cam and carrying the roller C, placed in the groove. When revolving the shaft, the yoke, guided by a bushing at D, will move back and forth three inches in a straight line. For laying out the cam proceed as follows: Set off from the zero point on the cam in a direction opposite to that in which the cam revolves, 90 degrees, and from this point set off 180 degrees, and then another 90 degrees, which brings us back to the starting point. Determine the highest and lowest points on the cam, which in this case are located 8 and 11 inches
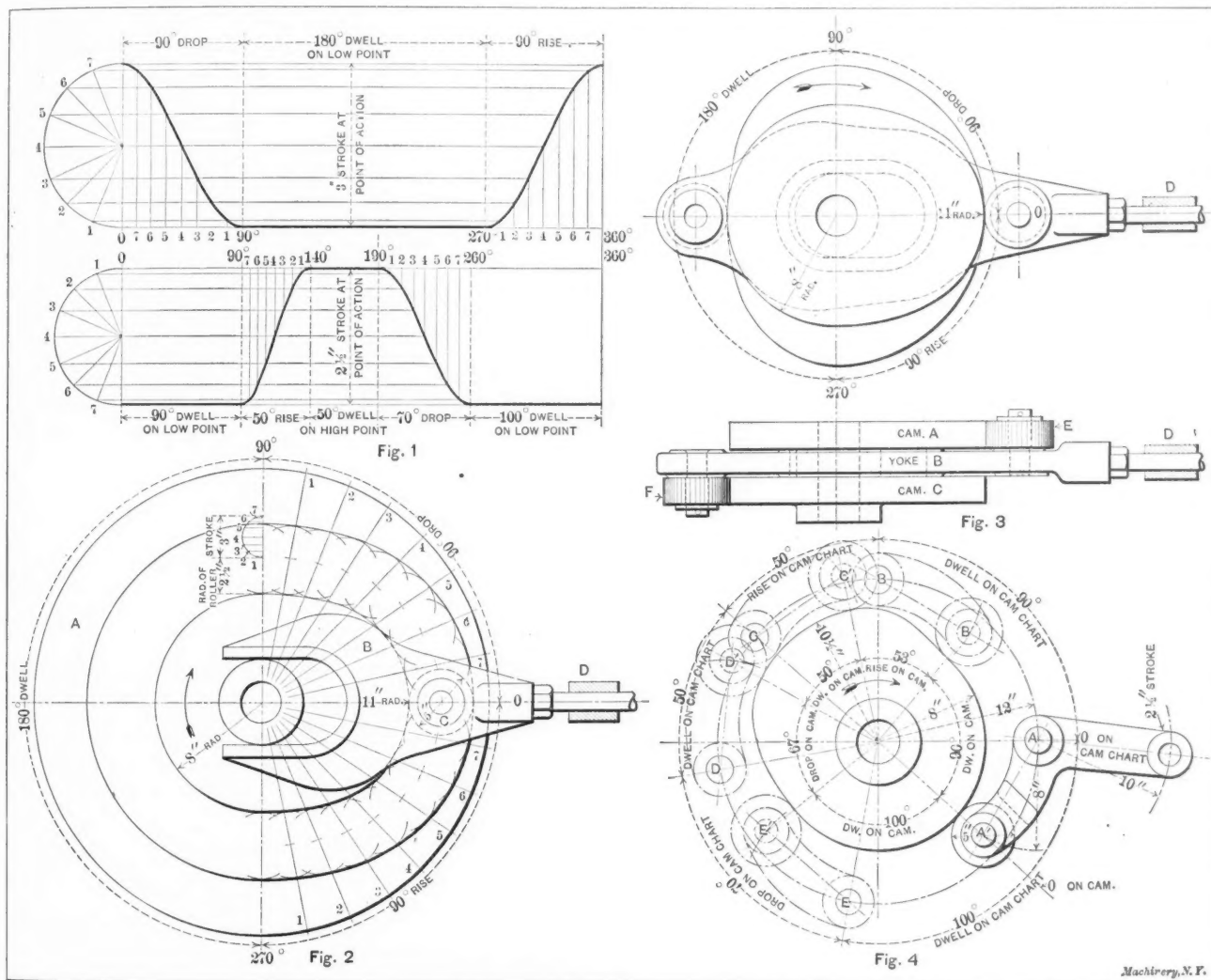
Cam Charts and Different Methods of Laying Out Cams

anism operated by the second cam rests until the cam has turned 90 degrees; the cam then imparts a motion of 2½ inches from 90 to 140 degrees. There is then a dwell for 50 degrees, a return motion during 70 degrees, and finally a 100-degree dwell on the low point of the cam.

The crank-motion curves on the cam chart are constructed as follows: Set off the stroke of the mechanism, three inches in the first case, and two and a-half inches in the second. Construct a half-circle with the length of the stroke as diameter, and divide the half-circle into a certain number of equal parts. Also divide the length representing the drop and rise into the same number of equal parts as that into which the half-circle has been divided. Then draw lines from the dividing points as shown in Fig. 1. The intersecting points will be

from the center respectively. Set off at the lowest point (as shown at the top of the cam in Fig. 2) the radius of the roller and the stroke of the cam, which latter, of course, is the same as the difference between the highest and lowest points. Draw a half-circle having the stroke for its diameter, as shown, divide the circumference of the half-circle into the given number of equal parts, and draw perpendiculars from the division points to the diameter or base line. Then divide the angles for the rise and the drop into the same number of divisions as that of the half-circle, and draw radii to the division points from the center of the cam. From the points where the perpendiculars intersect the base line draw circular arcs with the center of the cam shaft as a center until the arcs intersect the corresponding angular division lines. Take the points of intersection for centers and draw circles having a diameter equal to the roller diameter. The line tangent to these circles is the true crank-motion curve.

* For additional information on this and kindred subjects, see "Method of Laying Out and Cutting Cams," MACHINERY, October, 1908, and other articles there referred to. See also MACHINERY's Reference Series No. 9, "Designing and Cutting Cams."
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The second cam construction, Fig. 3, consists of two cams *A* and *C*, one on each side of the yoke *B*, and two rollers *E* and *F* mounted on each side of the yoke. The yoke in this case is also forked over the hub of the cams and guided at *D*. The cam curve for the top cam is identical with the inner curve in Fig. 2, and is laid out in the same manner, as is also the rise and the drop for the bottom cam. The only difference is that when the top cam has a dwell on the high point the bottom cam has a dwell on the low point, and *vice versa*. This, of course, insures a positive movement both ways.

Fig. 4 shows another cam construction laid out from the second chart in Fig. 1. It consists of only one cam, a lever and a roller. This construction is positive only one way and must be actuated by a spring for returning, but it can be arranged to work positively by making a three-arm lever, a return cam and a return cam roller. The point illustrated in Fig. 4 is the variation of the angles of the cam, as compared with those of the cam charts, due to the rise and the drop of the roller on the end of its lever. Instead of turning the cam shaft in the direction indicated by the arrow, assume that we swing the center of the lever pivot in a circle around the center of the cam, but in the opposite direction to the cam motion. To lay out the cam, we must first assume the length of the lever, the stroke of the cam, and the highest and the lowest points on it. The center of the lever pivot, at the start, will be at zero on the cam chart, and the center of the roller will be at zero on the cam. From the zero of the lever pivot, Fig. 4, set off 90 degrees for the dwell on the low point, 50 degrees for the rise, 50 degrees for the dwell on the high point, 70 degrees for the drop, and then 100 degrees for another dwell on the low point. Draw radii from the center of the cam shaft to each of these divisions. Take the points where these radii intersect the circle along which the center of the lever pivot moves, as centers for circular arcs having the roller arm *AA'* for radius, as shown at *BB'*, *CC'*, *DD'* and *EE'*. Then set off, from the center of the cam shaft, a distance equal to the radius of the cam plus the radius of the cam roller at each of these places (at *B'* the distance set off would be 8+2½; at *C'* 10½+2½, etc.). The points of intersection between these distances and the arcs struck with radii *BB'*, *CC'*, etc., are used for centers for circles having a diameter equal to that of the cam roller. Now it will be seen by measuring with a protractor, that where the dwell occurs the angle of the cam will be the same as the angle on the cam chart, but where a rise or a drop takes place the angles will be different.* In the present case, the 50-degree rise on the cam chart and of the cam lever will be about 53 degrees on the cam, and the 70 degrees drop on the cam chart will be about 67 degrees on the cam. This is of importance when several movements are used, and one movement starts immediately after another in such a relation that one must come to rest before another starts. The curves for the cam can be laid out in a manner similar to that explained in Fig. 2.

* * *

"A full conception of infinity is impossible to the finite mind," said the learned professor to his class, "and it is doubtful if an approach to it even is possible, but to illustrate in terms that will convey to your minds something of its immensity, let us consider infinite time. Suppose that the highest peak in the Himalayas were a solid diamond mountain and that an eagle came to it to sharpen his beak once in a hundred years. In the lapse of untold billions of centuries that diamond mountain undoubtedly would be worn away to dust. That is an illustration of finite time of great duration, but great as it is we cannot use it as a 'time-stick' to gage eternity."

* * *

In a recent address on Business English at Tufts College, Walter B. Snow, publicity engineer, of Boston, chose the modern advertisement in its display of force, terseness, knowledge of subject and consideration of the person addressed, as typical of the elements to be embodied in commercial intercourse and in technical reports, articles, etc.

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* For a more thorough explanation of this kind of cam construction see MACHINERY, October, 1908: Method of Laying Out and Cutting Cams.

THE McKINLEY MANUAL TRAINING SCHOOL, WASHINGTON, D. C.*

GEORGE W. SUNDERLAND†

The subject of industrial education is becoming more and more important throughout the United States. It is now recognized that the training of the hand and mind together confers far greater benefits than the training of either separately. The object of industrial education is not necessarily that a boy or girl who has passed through the manual training school must follow any of the trades or vocations of which
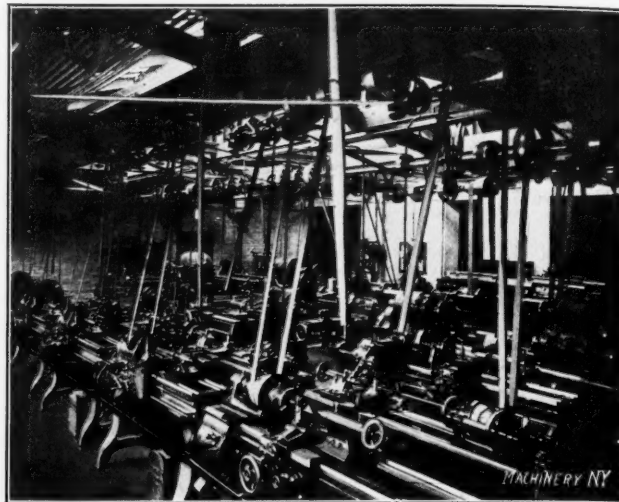

Fig. 1. View of Machine Shop, McKinley Manual Training School. Washington, D. C.

they have acquired some knowledge; but education of this kind gives them a broader view of the advantages of a trained hand in combination with a trained mind, and it aids them in determining for themselves what they are best adapted for. Nearly all of the largest cities in the United States now have manual training or technical high schools, where regularly prescribed courses are followed, while in small communities the idea is carried out to some extent, even if sometimes on a reduced scale.

Among the foremost manual training schools in the country is the McKinley Manual Training School of Washington, D. C. The school-building is strictly fireproof and contains seventeen class-rooms, besides three rooms devoted to chemistry, five

Fig. 2. Another Interior of the Machine Shop

rooms to physics, four rooms to free-hand drawing, two rooms to domestic art, four rooms to domestic science, four rooms to mechanical drawing, one library, one assembly hall with a seating capacity of 700, one art metal shop, one machine shop, one forge shop, two carpenter shops, one engineering laboratory, one shower bath-room, and the necessary lavatories, etc. The very names by which these rooms are designated suggest the purposes for which they are used, but a long and detailed

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* For additional articles on this and kindred subjects previously published in MACHINERY, see issue of September, 1907, Education for Industrial Workers, and the articles there referred to.
† Head Instructor of machine shop work, McKinley Manual Training School, Washington, D. C.

description would be required to convey an adequate idea of their complete and substantial equipment.

Three courses of study are provided. A general scientific course, a technical preparatory course (both requiring four years), and a special technical course, requiring two years. In connection with the manual training work, there is given a thorough course in English, French, German, physics, chemistry and mathematics. The part of the course which is of especial interest to the readers of MACHINERY, is the machine shop course. This includes instruction in the use of measuring instruments and tools, and as thorough a course as possible in bench, vise and floor work, drill press, lathe, planer, shaper, milling machine and grinding machine work, as well as instruction in the first principles of gearing.

The school has its own plant for power, heat, light and ventilation. The equipment consists of four Heine safety boilers of 75 horse-power each; one Ames high-speed, direct con-
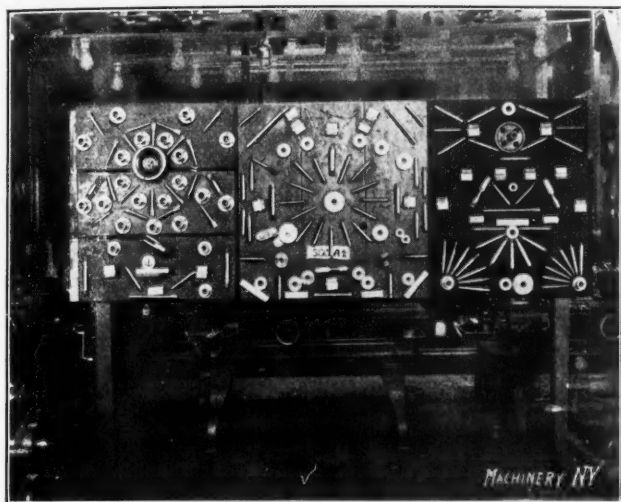

Fig. 3. An Exhibit of Work made by the Students in the McKinley Manual Training School

nected engine of 150 horse-power with a Westinghouse direct-current 100 K. W. generator, 125 volts, 800 amperes, 200 R. P. M.; one American Ball engine and generator, 50 horse-power, 125 volts, 230 amperes, 323 R. P. M.; one General Electric engine and generator, 80 horse-power, 125 volts, 400 amperes, 400 R. P. M.; one Johnson temperature regulator; one Cochrane feed water heater and return tank; two steam pumps for the boilers; two Sturtevant fans connected direct to motors, each 16 horse-power, 110 volts, 114 amperes, 975 R. P. M.; one Westinghouse 15 horse-power steam turbine driving a centrifugal pump.

The equipment of the machine, forge and carpenter shops will no doubt be of interest and value to others interested in the equipment of manual training schools. The following is a list of the machinery in the machine shop:

One 16-inch—10-foot Pratt & Whitney new model engine lathe, motor-driven.

Two 14-inch—6-foot Pratt & Whitney tool-room engine lathes, motor-driven.

One 16-inch—6-foot Hendey geared head engine lathe, motor-driven.

Two 14-inch—6-foot F. E. Reed geared head engine lathes, motor-driven.

Four 14-inch—6-foot F. E. Reed engine lathes, belt-driven.

Six 12-inch—5-foot F. E. Reed engine lathes, belt-driven.

One 14-inch—6-foot Hendey engine lathe, belt-driven.

Four 12-inch—5-foot Hendey engine lathes, belt-driven.

One No. 1 Brown & Sharpe universal milling machine, belt-driven.

One No. 3 Brown & Sharpe universal milling machine, belt-driven, with all attachments.

Three 16-inch Stockbridge shapers, latest type, motor-driven.

Three No. 1½ Brown & Sharpe universal milling machines, motor-driven, with all attachments.

One 16-inch Potter & Johnston shaper, belt-driven.

One 36-inch—6-foot Pease planer, belt-driven.

One 24-inch Prentice drill press, belt-driven.

One 22½-inch Willey drill press, motor-driven.

One 12-inch Willey sensitive drill press, motor-driven.

One Wilmarth & Morman "Yankee" drill grinder, motor-driven.

One No. 3 Brown & Sharpe cutter and reamer grinder, motor-driven.

One No. 2A Landis universal grinding machine, motor-driven.

Two Willey tool grinding machines, motor-driven.

One Walker "Globe" grinding machine, belt-driven.

One Hisey center grinder, motor-driven.

One Willey center grinder, motor-driven.

One Pratt & Whitney centering machine, motor-driven.

One Higley metal saw, motor-driven.

One Chicago gas furnace.

One Greenerd arbor press.

One L. S. Starrett display cabinet.

One Brown & Sharpe display cabinet.

One "Pike" oilstone display cabinet.

The shop is equipped with the necessary benches and vises. The tool-room is stocked with a full line, from a hack-saw to a micrometer, including the Pratt & Whitney Co.'s small tools. The check system is used. The stock-room is furnished with "New Britain" metal racks and metal shelving. It makes the most complete and non-combustible arrangement that can be found. The Higley metal saw is placed in the stock-room to give greater convenience in handling material.

The carpenter shop has a stock- and tool-room and a full line of tools as follows:

Thirty-six Oliver lathes, motor-driven.

One Oliver band-saw, motor-driven.

One Oliver buzz-saw, motor-driven.

One No. 3 Oliver trimmer.

One Oliver jig-saw.

One Oliver band-saw, belt-driven.

Twenty F. E. Reed lathes, belt-driven.

One Brown & Sharpe grindstone, motor-driven.

Two Willey tool grinders, motor-driven.

One demonstration bench for molding.
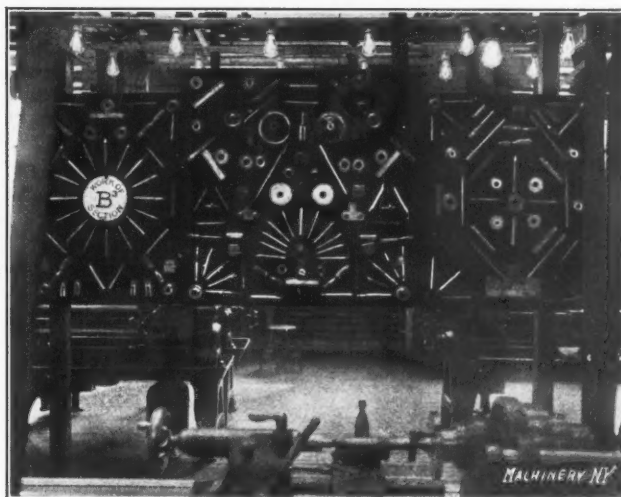
Fig. 4. Another Exhibit of Students' Work

A course in bench work is provided in connection with wood turning and pattern-making.

The forge-shop has the following equipment:

Twenty No. 02 Buffalo down-draft forges.

Ten B. F. Sturtevant ideal down-draft forges.

One No. E1 Dupont power hammer.

Thirty-one anvils.

One Buffalo 7½ horse-power blower, motor-driven.

One Sturtevant, 15 horse-power exhaust fan, motor-driven.

One Norton floor grinder 18-inch, belt-driven.

One "McKinley" drill press, belt-driven.

Two of the accompanying half-tones, Figs. 1 and 2, show interior views of the machine shop, and Figs. 3 and 4 illustrate some of the work done by the students. A great deal of the success of the school is due to the untiring efforts of Mr. J. A. Chamberlain, supervisor of manual training of the District of Columbia, who has been with the school since its infancy, and also to Dr. George E. Myers, the principal, who has shown great interest in all matters pertaining to shop work.

MACHINE SHOP PRACTICE*

CENTERING

While the importance of centering work properly, is appreciated by almost every machinist and most apprentices, still, in spite of this fact, inaccuracy in a turned part is often the result of haphazard centering. This is perhaps due more to the lack of care and thought than to anything else. When there are no special tools provided for centering, of course, too much cannot be expected in the way of accuracy; but even though the equipment consists only of a center-punch, there is no excuse for the form of center illustrated in Fig. 1. The center-punch should, however, never be used if it can be avoided. A better method is to locate and mark with a punch, centers in each end of the work and then drill and ream the ends with a combination drill and countersink, such as is illustrated on the Shop Operation Sheet accompanying this number. The center will then appear as shown in the sectional view, Fig. 3. The small straight hole a prevents the point of the lathe center from coming in contact with the work and insures that there will be a good bearing throughout the conical surface c, providing the angularity of both the lathe and work centers is the same and their axes coincide.
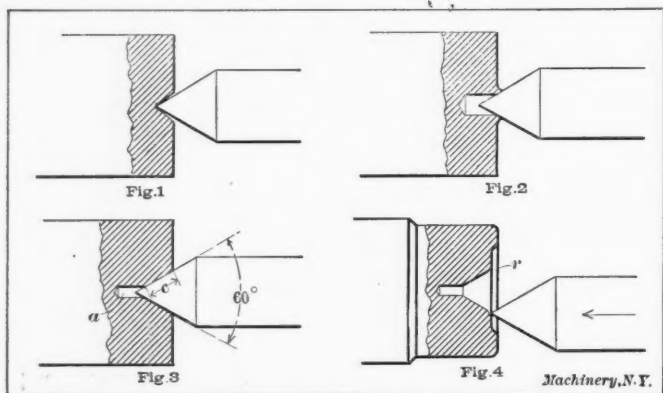
Figs. 1 to 4. Centers of Incorrect and Correct Form

Many shops are equipped with a regular centering machine. If such a tool is available, it is not necessary to locate centers in the ends of the work, as the chuck of the machine is so constructed that it automatically centers shafts of any diameter within its capacity, with reference to the drill. The center shown in Fig. 2, which is formed by simply drilling a straight hole in the end of the work, is, obviously, bad practice in more than one respect. Fig. 4 shows a form of center which is often found in the ends of lathe arbors. As the illustration shows, the mouth of the center is rounded at r and the end of the arbor is recessed. This is done to protect the center against bruises. The rounded corner is particularly desirable as the point of the lathe center is thereby prevented from catching on it when, at times, it is moved rapidly towards the work, which is not being held centrally by the workman.

When stock which is to be turned, is bent, it should be straightened before the centers are drilled and reamed. If
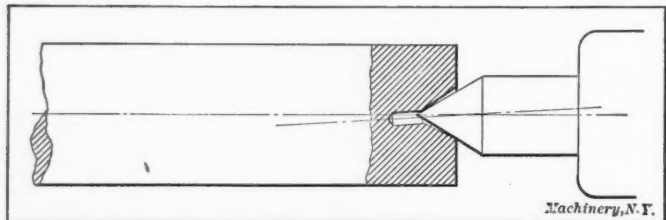

Fig. 5. The Poor Center Bearing shown is the Result of Centering before Straightening

the work is first centered and it is then bent considerably to make it straight, the bearing on the lathe center would be as shown in Fig. 5; consequently, the center would wear unevenly with the result that the surfaces last finished would not be concentric with those which were turned first.

Stock for tools such as reamers, mills, arbors, etc., which need to be hardened, should always be centered so that the rough stock runs approximately true. This is not merely to

* With Shop Operation Sheet Supplement.

insure that the piece will be true when it is of the required size, as there is a more important consideration, the disregard of which often greatly affects the quality of the finished tool. As is well known, the degree of hardness of a piece of steel that has been heated sufficiently and then suddenly cooled, depends upon the amount of carbon that it contains, steel
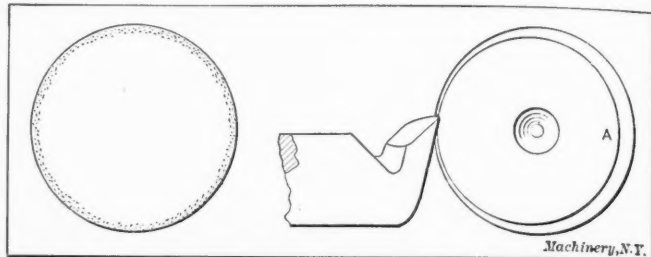

Fig. 6. Tool Steel should be centered Concentric, in order to remove the Decarbonized Outer Surface

that is high in carbon becoming much harder and more brittle than that which contains less carbon. Now the amount of carbon found at the surface, and to some little depth below the surface of a bar of steel, is much less than the carbon content of the rest of the bar, as illustrated diagrammatically in Fig. 6 by the shaded area of the view to the left. (This decarbonization is probably due to the action of the oxygen of the air on the bar during the process of manufacture.) Consequently, stock which is to be used for hardened tools should be enough larger than the finished diameter and so centered that this decarbonized surface will be entirely removed in turning. For example, if when making a reamer, the stock is so centered that the tool removes the decarbonized surface only on one side, as shown to the right in Fig. 6, obviously, when the reamer is finished and hardened, the teeth on the side A will be much harder than those on the opposite side. It will thus be seen that stock for such tools should not be too near to the finished size, in order that the decarbonized part will be entirely turned away. The depth to which the carbon is burned out increases with the size of the stock, and also varies somewhat with different pieces of steel. Generally speaking, about 1/16 or 3/32 inch should be removed for diameters near 1 inch, while for sizes of 2 and 3 inches, as much as 1/8 to 3/16 inch in one case and 1/4 inch in the other should be removed, respectively.
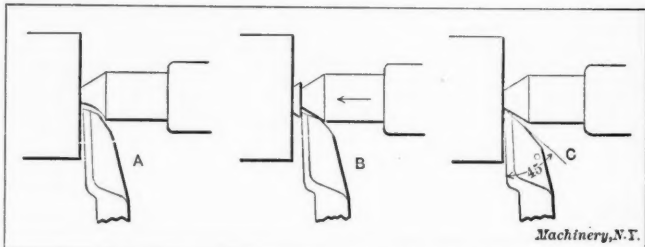
Fig. 7. Three Methods of Facing the End Square

As a piece of work would hardly be properly centered until the ends are faced square, we shall consider this operation, which, though simple, seems to be the cause for considerable comment. Some advocate the use of centers that are cut away, as shown at A, Fig. 7, so that the point of the tool may be fed in far enough to face the end up to the center. Others instead of using a special center simply loosen the regular one slightly, and then with the tool in the position shown at B, face the projecting teat by moving both tool and center simultaneously as shown by the arrow. This last method hardly represents good practice, but whenever it is employed, care should be taken to remove any chips from the center hole which may have entered. A method which is better than loosening the regular center or employing a special one, is to provide clearance for the tool point by grinding it to an angle of approximately 45 degrees, as shown at C. Providing the tool is not set too high, it may then be fed right up to the lathe center and the end squared without difficulty. As for the special center, the use of special tools and appliances in a shop should always be avoided unless they are essential to economical production, or their use makes it possible to accomplish the same end with an expenditure of less energy.

DRILL PRESS VALVE GRINDING ATTACHMENT

A. G. KENYON*

The attachment described in the following was made for the purpose of grinding in the valves of automobile cylinders in a drill press instead of by hand, as has been the practice for some time past. This operation has always been a source of some little annoyance and a time consumer, ever since manufacturers began to build engines in large quantities. A minute saved here and there very often means many more engines built in a month and many dollars saved on the month's expenses. The device shown in the accompanying engraving has proved itself well worth the amount it cost, although it was not at all expensive.

This attachment was designed for and placed on a two-spindle drill press made by the Fenn Machine Co. of Hartford, Conn. The machine is of the type in which the spindles are adjustable for center distance and it has a cross driving shaft A through the bases of the upright arms. This shaft is ordinarily driven by a pinion on the driving pulley which,
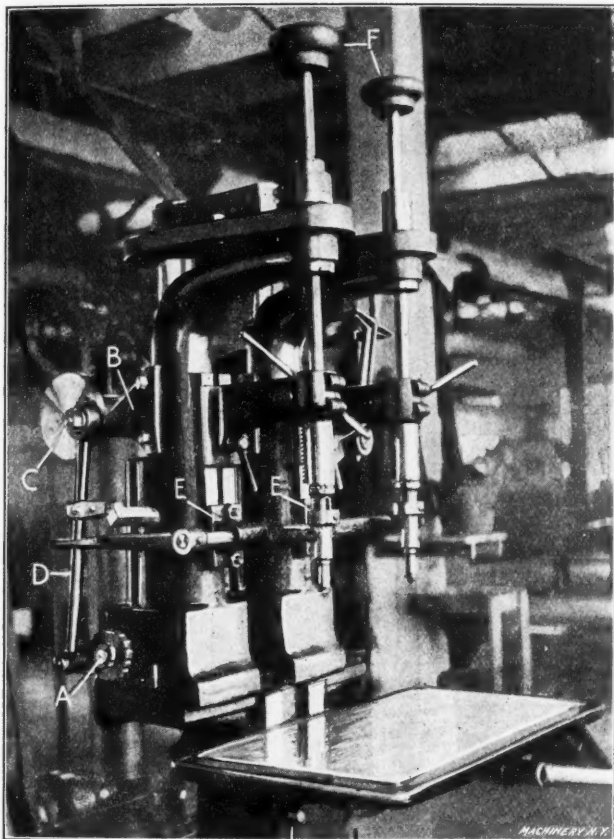
Drill Press equipped with a Special Attachment for Grinding Valves

together with the loose pulley, is carried on a stud set into the main stand casting. The cross shaft drives vertical shafts which are connected to the spindles of the machine by chains and sprockets. In order to make the attachment, the stud carrying the loose and driving pulleys was removed and also the gear on the end of the cross shaft. Castings B were made to fit the upright arms of the press and were cored out to allow for babbitting with the countershaft in place. The same two pulleys that were on the machine originally were placed on this shaft at one end. On the other end there is a disk, C, about six inches in diameter, which has a hub on one side to allow for set-screwing to the shaft. In this disk at the proper radius there is a shoulder-stud or crank-pin as shown. On the lower cross shaft A two ratchets are mounted, one made right- and the other left-hand. These ratchets are pinned to the shaft and in between them is placed a link or lever which carries two pawls to engage with the ratchet teeth. This lever also has a pin at its outer end and is connected to the upper shaft crank-pin by a connecting-rod D. The stroke of this connecting-rod is of the proper length to give the cross-shaft enough turn to move the spindles just half way around and then back again, the same as

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a workman does when he grinds valves by hand. One ratchet has twice as many teeth on its circumference as the other, and this one is placed on the inside. The pawl that drives this inside ratchet has a hardened pin on its side that trips over a block cut to the proper shape to cause it to disengage at nearly the bottom of the stroke. In this way the spindles of the machine make a full half revolution in one direction and then reverse and make almost a half revolution in the other. The result is that the valve, in the course of grinding, is advanced around its seat every other move, so that the seating is absolutely perfect. The reason for having one ratchet with twice as many teeth as the other, is to provide for the movement due to the momentum of the driven parts at the end of a stroke, so that the pawl will engage at almost any point on the circumference. In this way lost motion is largely eliminated, and consequently, there is no knocking or vibration while the machine is running.

As it is common practice with mechanics to place a spring under the valve head, while grinding, to raise it occasionally in order to let the grinding-in compound settle and change in the seat, this is done in this case. Two castings E were made to fit the front T-slot, and these support a rod three-quarters of an inch in diameter on which is placed three forgings, two of which are forked at the end and straddle the spindles of the machine as shown. The other is forked at the end and straddles the connecting-rod. Collars were made to fit the spindles and a clip was also made to fit the connecting-rod. This clip is so adjusted that when the connecting-rod is at the bottom of the stroke, it strikes the forked lever and causes it to move down. This brings the forked levers at the spindles in contact with the collars on the spindles and, consequently, raises them slightly. As the pressure is then removed from the valve, it rises just the same as it would if it were being ground by hand. These levers are so located with reference to the collars on the spindles, that none of the grinding pressure is removed from the valves except at the time of lifting. The grinding pressure is obtained from two cast-iron weights F on the spindle shafts. The drivers are like a screw-driver, except that in the center of the blade a center is left projecting so that it will settle in the countersunk lathe center usually left in the heads of valves. These drivers are placed in old drill shanks that fit the sockets of the spindles. These drill shanks are bored out a little larger than the shank diameter on the driver and a pin is placed through them that fits loosely in the driver shank. This gives the driver a sort of floating action and allows the valve to find its own seat and center, which it would not do if the valve center was not quite in line with the spindle center and a rigid driver were used.

The cylinders, the valves of which are ground with this fixture, have four cylinders cast "en bloc" with the valves all on one side. As the distance between the spindle centers is adjustable, they are set to the first and fifth valves so that it only takes four moves to complete the grinding of one set of valves. Either spindle can be raised independently of the other at the will of the operator by the ordinary means for raising a drill press spindle, which was not interfered with in the least in attaching the device. Either spindle can be stopped also by simply shifting a lever on the back of the machine to a neutral point. This is also a part of the regular equipment of the press that was not interfered with.

This device has been in use now for some time and has repeatedly ground all eight valves in a cylinder, perfectly, in seven minutes. It positively does not ring the valve, nor does it chatter the seat in the least, and in every way it has proved successful beyond our expectations. The engraving shows how comparatively simple the device is to make and attach, if a shop has a drill press of this make or style. This fixture has solved the valve grinding troubles in our own shop for some time and we hope that if anyone else builds one, it will be as successful as ours has been.

* * *

The Prussian state railways have specified that 214, or about 35 per cent, but of 611 locomotives ordered to be delivered between October, 1909, and March, 1910, are to be provided with Schmidt superheaters.

SOME ECONOMIES IN MAKING DRAWINGS

W. E. WILKINSON*

The engineering staff connected with a manufacturing establishment is usually regarded as a necessary evil because it is not directly remunerative, and it is tolerated only because it cannot well be dispensed with; this is because drawings and designs are not an end in themselves, but a means to an end—a graphical representation of ideas, more or less thoroughly depicted, for the conveyance of the same to others to be wrought out; concrete thoughts in a universal language, if one chooses to put it that way. Whatever ways and means of shortening processes and eliminating unnecessary expense, that can be employed without depreciating either the quality or quantity of work produced is of interest to all concerned
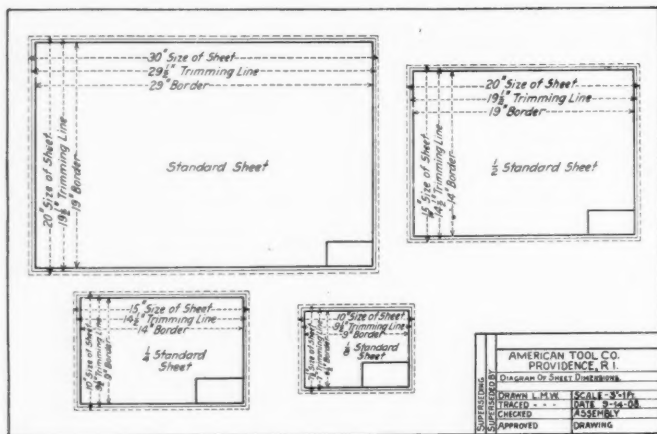

Fig. 1. Dimensions of Standard Drawings

with such offices. With these objects in view the following suggestions are made, which are thought to be generally applicable in any engineering office or drawing room, whatever the size may be.

The best general practice seems to be to have competent designers for making general plans who will pencil the work only; detail draftsmen and tracers to complete the work; efficient checking and inspection of each part; all drawings to be made to scale and on standard-sized sheets invariably; each detail made separately with as many views on the sheet as may be needed to make the subject clear. The advantages of small size sheets are that they are more convenient in the shops and if subsequently changed—as most are—the changes do not affect other detail sheets. The smaller sheets should be subdivisions of the larger, as shown in Fig. 1, so that if desired the entire construction, including the details, may be blue-printed on large sheets and the whole suitably bound into uniform-sized folios or booklets.

The first suggestion is that each sheet of tracing cloth be given to the tracer with the border and title stamp printed on it. The advantages are that the sheet will be smooth and flat at the start, absolutely uniform in size, appearance, title and all that pertains to it, and only the blanks in the title will need to be filled in by the detailer. The prime advantage is the saving in time, which will range from 10 to 25 per cent in average cases, and even more on small sheets, where the work detailed is comparatively quickly executed. Hand-written titles are an abomination unless done by an expert, whose time should be better employed. Rubber stamp work is seldom satisfactory and no good substitute for a properly printed title is thought to exist. The first expense may seem heavy, as it means the purchase of a considerable amount of cloth at one time, but there is no waste or time lost in cutting, which will more than counterbalance the slightly increased cost of having the material cut and printed in quantities.

A second economy lies in the use of properly prepared lists of every possible small part, such as screws, bolts, nuts, washers, pins, etc., using a symbol for the same in place of making detail drawings. In fact, this list system is capable of almost indefinite expansion, limited only by the special requirements of the particular factory in which the work is to be done; besides serving as economizers of time, they materially prevent errors and mistakes and also serve to avoid the drawing

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of a multiplicity of small parts, which are almost duplicates. Such lists may have at their head a drawing representing the object and a symbol, as a letter, used exclusively for it. In place of dimensions on the object, let the same be given symbolically and the list so arranged that all of its proportions beginning with the smaller sizes, preferably, can be determined and a distinguishing mark, as a numeral, be united to the subject symbol so that its relative size may be known at a glance.

Another suggestion, perhaps more applicable to larger objects having a greater number of dimensions, is to have printed sheets bearing a representation of the object, the dimensions being left blank to be filled in by the draftsman as may be required. In place of printed objects, which would be expensive if but few of a kind were required, the same results may be attained by well executed tracings, filling in the blank dimensions on the prints, the same as would be done on original drawings (see Fig. 2). Don't forget to file a duplicate, however, for future reference.

Where mere sketches are required, cross-section paper, a sheet of carbon and a hard copying pencil may be utilized, but this will not do very well for permanent records and is a make-shift at best.

A further economy in any engineering department may be effected by the use of a record file, kept carefully and fully up to date. The time lost in hunting for some mislaid drawing is not productive of profit or pleasure to any concerned, yet it is the too common experience. Possibly if less cheap (?) labor were employed and this work more generally in the hands of competent persons, made responsible for the instant production of any drawing, the results would justify the expense.

Of course a blueprint machine is installed if the office is of any considerable size, but how about the facilities for washing and drying prints? A sloppy sink may answer for the first, but on a dull or rainy day, wet paper dries slowly and a delayed print often means direct loss by reason of holding up the mail, a customer or a machine. A steam coil or electric heater can generally be readily arranged and will save its cost many times over in a short time.
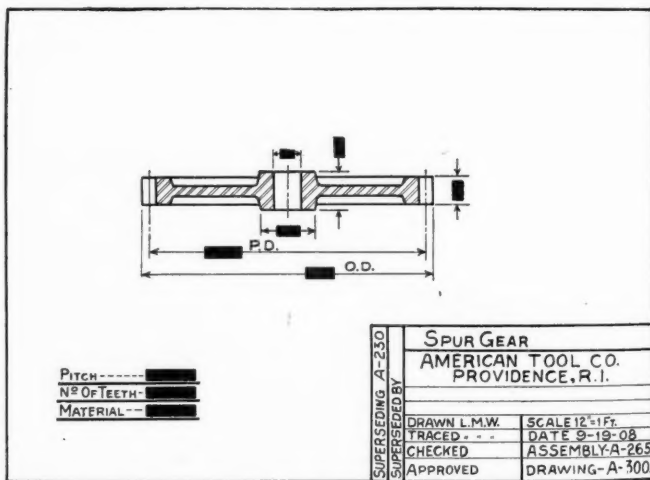

Fig. 2. Printed Sheet with Representation of Commonly used Part and Blank Spaces to be filled in by the Draftsman

A mistake frequently made is to change tracings, involving erasures and re-inking; generally the tracing is spoiled and in any case is lost as a record. It is far better to retrace wholly, making such changes as are desired, as less time is likely to be required and better results attained, while both the old and new tracings may be preserved.

The use of tracing paper is also thought to be a mistake, as it is so easily crumpled, torn and rendered useless for permanent records; the practice can only be condoned on the possible score of extreme urgency.

In conclusion, as time is the most important factor in drawing-room expenses, it should be the duty of some one constantly within reach to see to it that supplies are immediately available to such as require them, and that sufficient data be given so that workmen do not have the common excuse of waiting for this or that, when idle, be it an article of use or a word of explanation or information.

FORMERS FOR CUTTING BEVEL GEARS*

The most common method of making bevel gears at the present time is, perhaps, that of using formers for shaping the gear tooth. The pin or roller, controlling the part in which the cutting tool is held, guides this so that a tooth of the same shape as that of the former will be cut by the tool. It would seem at first that a great many different formers would be required in order to make possible the cutting of bevel gears of different pitch diameters, pitch and pitch cone angles. It is the object of the following analysis to show that correct bevel gear teeth may be planed by the use of a comparatively small number of formers.

In Fig. 1 a bevel gear is shown, and at the left is indicated the former, the path of the cutting tool being guided by a pin moving over same. The gear here shown has a comparatively wide face. Imagine this gear cut up into a number of gears with narrow tooth face. These gears would then have the same number of teeth, but they would have different pitch diameters, and consequently would be of different pitch; yet all

planing machine is so constructed that the former can be adjusted for planing the opposite side of the tooth, then the same former will be suitable for cutting all gears having the same effective radius, irrespective of the number of teeth in the gear; therefore the conclusion previously arrived at may be further extended by saying that within the capacity of the machine, all bevel gears having an equal pitch cone angle can be cut with the same former irrespective of the pitch or the number of teeth. In other words, the shape of the former depends on the angle of the pitch cone only.

The question of the angular limits of the pitch cone angle between which each former can be employed without serious inaccuracy in the tooth form is a highly important one. In other words, it is necessary to determine how many formers will be required for the full capacity of the machine, assuming, for instance, that it will commence to cut gears with a pitch cone angle of about 10 degrees up to 160 degrees. Certain (German) makers of milling cutters for spur gear teeth make these in sets of 15, this giving a very close degree of accuracy
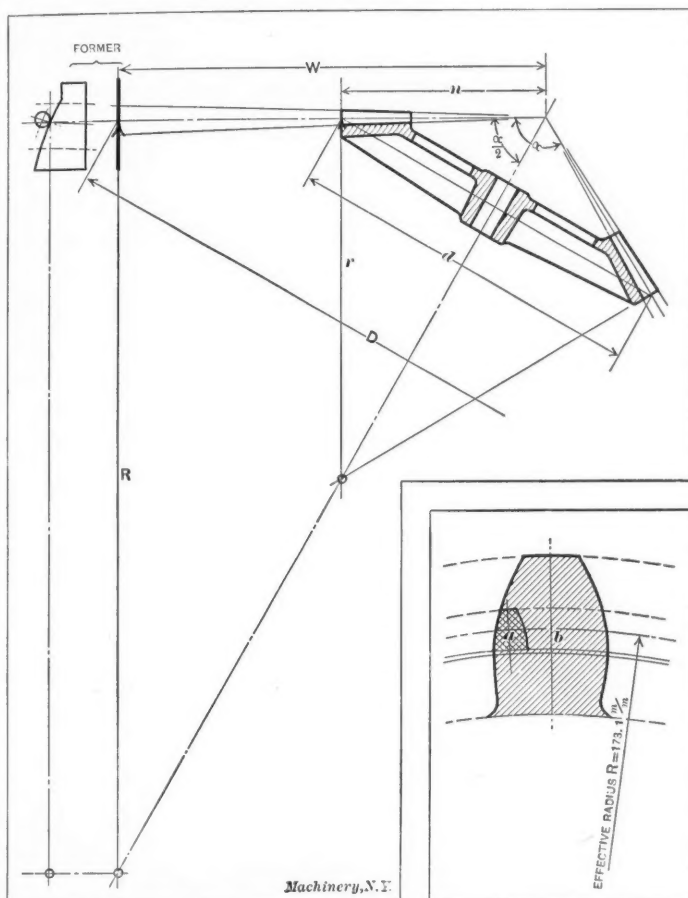

Fig. 1. Diagram for Proving that the Shape of the Former is Independent of the Pitch of the Bevel Gear
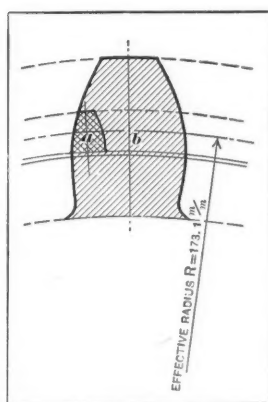
Fig. 2. Diagram showing that the Same Former can be used for Planing Different Numbers of Teeth
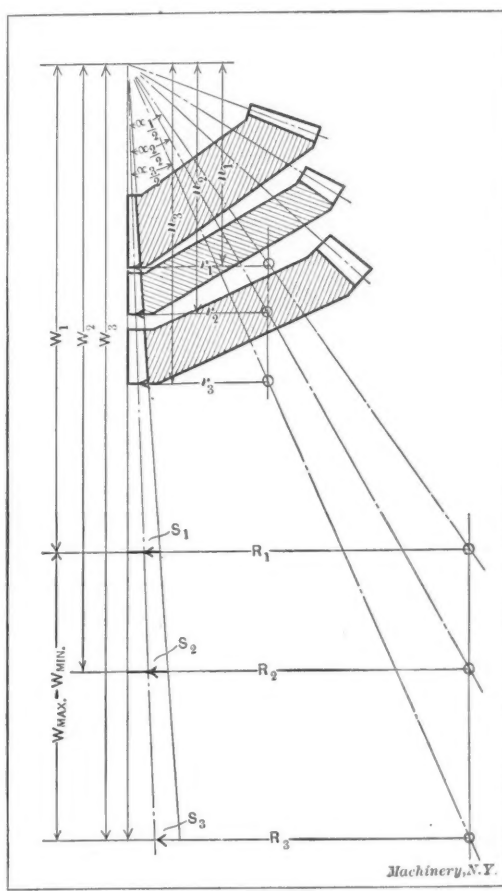
Fig. 3. Diagram showing how Correct Bevel Gear Teeth can be cut with a Limited Number of Adjustable Formers

being a part of and identical with a single gear which can be cut by a single former, it is clear that a single former is sufficient for cutting all bevel gears within the capacity of the machine without regard to the pitch, provided the gears have the same number of teeth and the same pitch cone angle.

On account of its simplicity, the involute form of tooth is almost exclusively used for bevel gears, and the following investigation will cover this form of tooth only. The form of the involute curve depends entirely on the length of the radius r (Fig. 1). This radius equals $\dfrac{d}{2}$ divided by cosine $\dfrac{a}{2}$. In the following this radius r will be known as the *effective radius*.

In Fig. 2 are shown two teeth from gears having widely different pitch. The illustration indicates how the same former can be used for both teeth provided the former is large enough so that the full length of the tooth flank of the larger tooth can be formed from it. It is clear that if the bevel gear

* Abstract of an article by H. Becker, *Werkstatts Technik*. September, 1909. See also an article entitled Adjustable Former for Bevel Gear Planing, MACHINERY, December, 1906.

for all numbers of teeth. It would be reasonable to base calculations for limits of tolerance for bevel gear formers on the same basis as has been used for determining the number of teeth for the 15 cutters in a set of spur gear cutters. An example may illustrate this more clearly. Assume that the bevel gear planing machine has a capacity for cutting all bevel gears up to a modulus of 20 and with pitch cone angles of from 10 to 160 degrees. Assume that the smallest number of teeth is 12. Then we have the required circular pitch for the former (see Fig. 1):

$$\text{Circular pitch} = \frac{W \sin \dfrac{a}{2} \times 2\pi}{\text{Number of teeth}}$$

and the modulus is

$$\text{Modulus} = \frac{\text{Circular pitch}}{\pi} = \frac{2W \sin \dfrac{a}{2}}{\text{Number of teeth}}$$

In this case then the modulus equals 64.5, W being equal to 1,500 millimeters and a being assumed as 30 degrees, this

being the greatest angle that ought to be used when the number of teeth equals 12. The modulus found is the greatest one for any former for the machine, and from this one the other formers must be determined.

We have previously said that the involute form depends only on the pitch cone angle, or on the length of the effective radius r. The number of teeth in the present case corresponding to the largest pitch cone angle $a = 160$ degrees would be

$$\text{Number of teeth} = \frac{2W \sin \dfrac{a}{2}}{\text{Modulus}} = \frac{2 \times 1,500 \times \sin 80°}{20} = 148.$$

TABLE GIVING PITCH CONE ANGLES FOR DIFFERENT FORMERS

No. of Spur Gear Cutter (or Corresponding Bevel Gear Former)	No. of Teeth for which Spur Gear Cutter is intended	Pitch Cone Angles for which Former can be Used	Exact Angle to which Former Corresponds
1	12	98° 48'— 10° 35'	10°
1½	13	10° 36'— 11° 25'	10° 55'
2	14	11° 26'— 12° 13'	11° 55'
2½	15— 16	12° 14'— 14° 1'	13°
3	17— 18	14° 2'— 15° 27'	14° 30'
3½	19— 20	15° 28'— 17° 3'	16°
4	21— 22	17° 4'— 18° 37'	17° 30'
4½	23— 25	18° 38'— 21° 1'	19° 30'
5	26— 29	21° 2'— 24° 9'	22° 20'
5½	30— 34	24° 10'— 28° 3'	26°
6	35— 41	28° 4'— 33° 23'	30° 30'
6½	42— 54	33° 24'— 42° 53'	37°
7	55— 79	42° 54'— 59° 27'	49°
7½	80—134	59° 28'— 87° 53'	70° 30'
8	135— 00	87° 54'—180°	122°

From this equation, solved for $\dfrac{a}{2}$ we can easily determine the angles which correspond to the numbers of teeth for which the spur gear cutters are made; and in this manner, by comparing with a list of cutters for spur gears and seeing the number of teeth for which each cutter is intended, we can determine the limits of the pitch cone angles for which each former should be used. The accompanying table shows the results obtained from these calculations, and also gives the angle for which each former should be made.

While a machine provided with formers made with the limits indicated will cut gears which are practically correct, it would be advisable to have special formers made for such ratios as 1 to 1, 1 to 2, 2 to 2, 2 to 3, etc., so that in these cases absolutely correct teeth can be cut.

One of the most interesting considerations in connection with this subject is yet to be mentioned. While the formers are made for a certain pitch cone angle, and it therefore would appear that it would not be possible to make a bevel gear with perfectly correct teeth, except if it had a pitch cone angle corresponding to the angle for which the former had, in particular, been made, it is possible by a method now to be described, to produce theoretically correct teeth for all pitch cone angles with the formers mentioned. In Fig. 3 are shown three bevel gears with different pitch cone angles; the effective radii r_1, r_2, r_3, however, are equal for the three bevel gears. Therefore,

$$n_1 \tan \frac{a_1}{2} = n_2 \tan \frac{a_2}{2} = n_3 \tan \frac{a_3}{2}$$

From what has previously been said, it is clear that for producing the teeth in these gears one can use the same former, provided the distances W from the former to the apices of the pitch cones be made to correspond. If, for instance, on a certain machine W equals 1,000 millimeters, and an adjustment of 300 millimeters is possible, then W_{max} equals 1,300 millimeters. If the former corresponds to a pitch cone angle of 90 degrees when W equals 1,000 millimeters, then it will correspond to a pitch cone angle of 75 degrees 20 minutes when W equals 1,300 millimeters. It is also clear that when passing from 1,000 to 1,300 millimeters the former comes into intermediate positions corresponding to all angles between 90 degrees and 75 degrees 20 minutes. This arrangement has the advantage that a very few formers make it possible to cut

theoretically correct teeth for every angle within the limits of 10 to 160 degrees, even when the limits of the adjustment of the former on the machine are small. If the limit of adjustment of the former on the machine increases, it is evident that the required number of formers will decrease correspondingly, and a very few formers will be required for cutting correctly all bevel gears, whatever the pitch, pitch cone angle, or number of teeth.

* * *

PROCESS FOR HARDENING CAST IRON

R. F. WILLIAMS

An improved process whereby cast iron in the rough or in the finished state may be hardened or tempered, the hardness extending completely through articles of comparatively large dimensions, is described in the following. One of the principal objects of this process is to provide a cheap and simple method of rendering iron castings so hard that they may be used for many purposes in the place of steel, thus reducing the manufacturing cost of a large number of articles. The various steps of the process and the manner of carrying it out are here described. The castings which are to be treated by this process may be completely finished as regards machine work before they are hardened, and it will thus be seen that the wear on the machine is greatly reduced and the necessary labor is also less than where similar articles are made from hardened steel.

The casting is first heated in any suitable or convenient heating device, until it reaches a temperature sufficient to cause the casting to glow, or, in other words, to what is known as a cherry red heat. It is then dipped in a bath which consists of practically anhydrous acid, of high heat-conducting power, preferably sulphuric acid of a specific gravity of from 1.8 to 1.9, to which is added a suitable quantity of arsenic. The ingredients of the bath are sulphuric acid of a specific gravity of about 1.84 and red-arsenic (As_2S_2) in the proportions of ¾ of a pound of red-arsenic crystals to one gallon of sulphuric acid. The castings may be either suddenly dipped in this mixture and then taken out and cooled in water, or they may be left
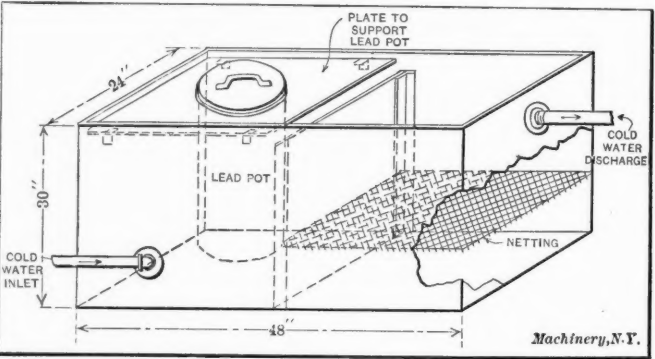
Cooling Tank and Hardening Bath for Cast Iron

in the bath until cooled. It has been found, however, that dipping the castings in the bath and holding them there for some time, which varies according to the size of the casting, and then completely cooling in water, is quite as satisfactory, and produces a material which is just as hard as if the castings were allowed to remain in the bath until cooled, and this method is preferable if a large number of castings are to be hardened, as the bath is thus prevented from becoming overheated. In preparing the bath, when sulphuric acid and red-arsenic are used, we find that better results are obtained when the crystals are added to the sulphuric acid and the bath is allowed to stand for about a week before using, the reason probably being that the bath becomes more saturated with the arsenious compound when the dissolved red-arsenic has been long in the sulphuric acid.

It is not necessary that the casting be machined completely before hardening, as rough finished castings may be hardened equally well. The change which takes place in the metal is in the nature of a molecular re-arrangement or re-crystallization coincident with an increase in the combined carbon at the expense of graphitic carbon, and in this change

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lies the difference between the results obtained by this bath and ordinary case-hardening processes, in which a certain portion of the carbon contained in the material of the bath is actually given up to the metal.

It is found that the more rapid the cooling of the metal, the harder it will become. For this reason the bath must be of high heat-conducting power, and this requirement is obtained by the use of the ingredients referred to. Furthermore, the bath must be practically free from water, as it is found that when the acid contains water in any considerable quantity, a steam cushion is formed between the acid and the metal which prevents their coming in contact, with the result that the cooling is less rapid, and, consequently, the iron is not so hard.

A cylindrical jar made of lead should contain the bath, the size varying according to the work to be done. A jar about 10 inches in diameter by 18 inches deep, will be about right for ordinary small work. This lead jar should be enclosed in an outer vessel through which water is caused to continuously circulate in order to keep it cool. It might be further pointed out that if it is desired to harden one portion of a casting and leave the remaining portion soft, this may be accomplished very readily by immersing only the part to be hardened.

Such a hardening equipment has proved very satisfactory in locomotive work for hardening bushings, etc., and many other uses could no doubt be found for it. The whole equipment can be homemade, consisting as it does simply of a steel tank divided into two compartments, and the lead jar for the bath, as shown in the illustration. The water circulates in the first chamber around the lead vessel, keeping it cool, and then passes to the second chamber, into which the castings are dropped, when taken from the bath, to cool off. The water then passes into the sewer or other suitable containing device. There is a screen placed in the second compartment to keep the castings from falling to the bottom. A lead cover should be made for the bath to keep the acid solution from evaporating, and a little care exercised by the workman so as to prevent the solution from splashing on him.

* * *

TIME OF EXPOSURE FOR DRY-PLATE PHOTOGRAPHY

In the January, 1909, issue of MACHINERY, engineering edition, an abstract was published of a paper on "Industrial Photography," by Mr. S. Ashton Hand, read before the American Society of Mechanical Engineers at the December, 1908, meeting. A contribution to the discussion on this subject was made by Mr. Charles W. Hunt, who submitted some interesting records of experiments made by himself for the purpose of estimating the proper time of exposure for dry-plate photography. The accompanying tables are based on this series of experiments. As a preliminary step, the altitude of the sun was calculated for each hour of the day from sunrise to sunset on the first day of each month of the year and the results plotted.

In June, 1905, a series of exposures was made with a Watkins exposure meter at each hour of the day, and a tentative table of the relative exposure time for each hour from sunrise to sunset was made. Using this tentative table, a series of similar exposures was made with dry plates. The plates were each developed the same length of time and in the same strength of developer. From these tests the tabular time was corrected. A table was then made giving the estimated time of exposure for each hour of the first day in each month in the year, basing the time of exposure largely upon the tests and the altitude of the sun in the different months. During the ensuing year this table was tested from month to month, and revised as experience indicated, in order to get the best attainable negative at any hour of the day in any month of the year. Table I is derived from the results of the above tests, with the formulas corrected to correspond with exposures made on Eastman films of 1908.

The time for a theoretically perfect exposure that will result in the best printing negative that the subject will give, cannot be expected from any formula that takes into consideration only the most prominent factors affecting the problem.

These rules may, however, be expected to give a reasonably close approximation to a perfect exposure. In making exposures where it is unusually important to secure a good negative, and the exposure cannot be repeated, make three exposures as follows: The first exposure with time as computed; the second, with one-half the computed time; the third, with double the computed time.

For less important cases, but where great uncertainty exists as to the proper time of exposure, proceed as above, but make only two exposures, the slowest and the fastest, omitting the computed time exposure. The latitude of the plate will give a satisfactory negative if the theoretically perfect time of exposure lies within very wide limits.

An exposure should not be made in a fog, and in hazy weather only of nearby subjects. Good negatives may be

TABLE I. COEFFICIENTS "A" FOR PHOTOGRAPHIC EXPOSURES IN THE LATITUDE OF NEW YORK

Month	Hour of the Day				
	7 to 8 or 5 to 6	8 to 9 or 4 to 5	9 to 10 or 3 to 4	10 to 11 or 2 to 3	11 A. M. 12 M. 10 P. M.
January-December ...	..	2	4	6	7
February-November..	..	4	5	7	8
March-October	2	5	6	8	12
April-September......	4	6	9	12	16
May-August..	5	8	12	18	28
June-July	7	10	16	24	32

made during a shower if the weather is otherwise clear. Generally, if contrast in the negative is desired, underexpose; if definition in the shadows is wanted, overexpose. When in doubt, it is safer to overexpose. Stops number 64 or 128 are excellent for general outdoor exposure; number 32 or 16, for indoor work. If it is desirable to emphasize a specific part of a machine, focus carefully with a large stop, and shorten the exposure to correspond with the stop.

The following formulas and tables are based on normal light conditions and ordinary subjects. If either or both are abnormal, the operator must make allowance in the duration of exposure as computed by coefficients from Tables I, II and III:

TABLE II. WEATHER COEFFICIENTS B

Clear, sunshiny weather.............................	1.0
Floating, white fleecy clouds.........................	1.0
Overcast, but a light day.............................	1.5
Cloudy, dull day	2.0
Lowery, heavy clouds	4.0

TABLE III. SUBJECT COEFFICIENTS T

Shop interior, dark and poorly lighted......	1000.0
Shop machinery fairly well lighted...................	400.0
Shop machinery placed near a good window light......	150.0
Machinery under sheds with one side open, or covered areas	15.0
Machinery outdoors to give details in the shadows....	2.0
Machinery outdoors, general views....................	1.5
Groups or portraits outdoors.........................	1.0
Buildings and nearby landscape.......................	1.0
Distant structures or landscape views................	0.5

Time Exposure

Assume a stop suitable for the subject and call it H; then the seconds to expose will be

$$\frac{H \times B \times T}{32 \times A} = \text{seconds exposure for an } H \text{ stop.}$$

Bulb Exposure

A "quick" bulb exposure is a time exposure of about 1/5 to 1/4 second. To compute the number of the lens stop, use the formula:

$$\frac{8 \times A}{B \times T} = \text{stop for a "quick" bulb exposure.}$$

* * *

A non-shrinking alloy can, according to the *Scientific American*, be made by melting together equal weights of tin and zinc. The alloy is hard when a good grade of zinc is used. Two parts of bismuth by weight to 50 parts of tin and 50 parts of zinc, will render the alloy very fluid and make it possible to pour it at a lower temperature.

LETTERS UPON PRACTICAL SUBJECTS

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively

MILLING INDEX DIALS

The charts shown in the accompanying illustrations, together with the following explanation, show how a rather complicated job of indexing was simplified to enable an operator who was familiar with only plain milling operation, to carry on the work.

It will be observed by referring to the drawing of the dial, Fig. 1, that the index lines, notches and set-screw must be in a fixed relative position. An index plate with a 54-hole circle was selected, and the degrees between the notches and lines on the dial were reduced to turns and holes for each movement as follows: As it requires forty turns of the crank to make one complete turn of the work, there is, in this case, $40 \times 54 = 2,160$ holes to one turn of the work, and a movement of one degree equals $2,160 \div 360 = 6$ holes. It is now only necessary to multiply the number of degrees given on the charts by six, to get the number of holes for each movement, and then divide by 54 to reduce the movement to turns
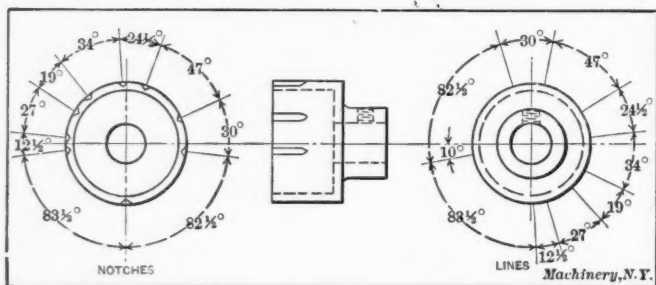

Fig. 1. Index Dial in which Notches and Lines are to be milled

of the crank and additional holes in the plate. For example, 10 degrees $\times$ 6 $= 60$ holes, or 1 turn and 6 holes.

The work of milling the index lines and the index notches was divided into two operations to avoid confusion, and two charts were made as shown in Figs. 2 and 3. The lines were

tion to mill the first line, the cutter having been previously set central. Then by indexing, in the direction of the arrow, the required number of turns and holes for each successive cut as indicated on the chart for milling lines, it is a simple
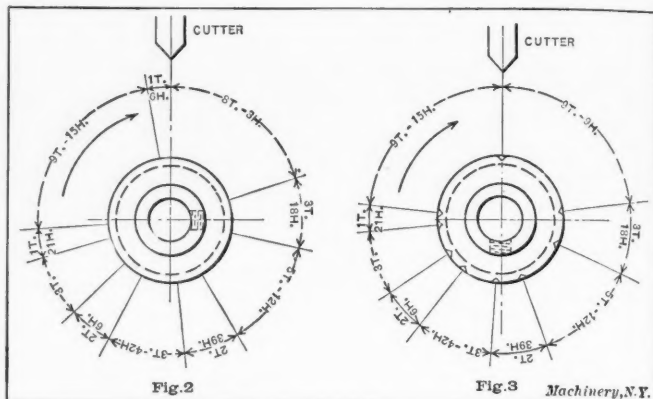
Figs. 2 and 3. Charts for Milling the Lines and Notches

matter to finish that operation. The work will then be in the original position. By referring to the chart for indexing the notches, it is found that one of them is in line with the set-screw hole. As this point makes a convenient starting place for the second operation, the work is indexed one-quarter turn or 90 degrees by ten turns of the crank. This brings the work in the proper position for starting the first cut. Then, by indexing in the direction of the arrow, as shown by the chart in Fig. 3 for milling the notches, the second operation is finished. C. G. H.

JIG FOR DRILLING AUTOMOBILE FRAMES

A jig for drilling automobile frames is shown in the accompanying engraving. This jig is designed for drilling the holes
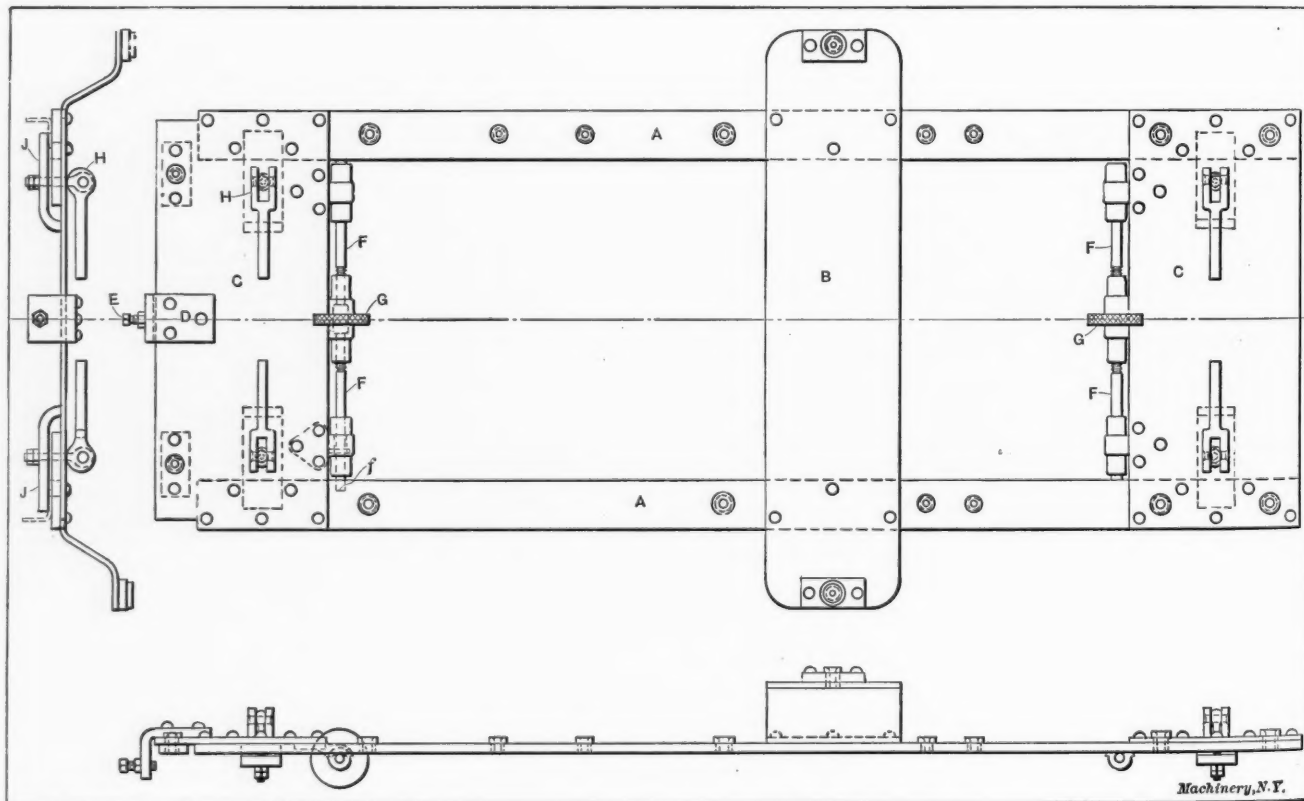
Adjustable Jig for Drilling Automobile Frames

milled first, and in starting great care was exercised to get the center of the set-screw exactly on the horizontal center line, and to the right, as viewed from the hub end. Now by indexing ten degrees, or one turn and six holes, we are in position

for the motor and transmission feet, dash anchor plate, radiator, clutch, and shifting yoke holes, all at one setting. The frames, when received, are riveted and have all the holes drilled, except the ones mentioned.

The jig, consists, principally, of two side members, *A*, made of ½ x 2½ inch machinery steel; one cross member *B*, made of ¼ x 7-inch machinery steel; and two cross members *C*, made of ¼ x 9-inch machinery steel. The parts are put together with 5/16-inch rivets. The bracket *D* is riveted to the front cross member *C* and it holds the jig in the proper position lengthwise. The screw *E* allows for adjustment. Bracket *D* is made of 1½ x 2½-inch machinery steel and it is riveted to the cross member *C*. The jig is centered by the four adjusting rods shown at *F*; the points *f* bear against the inside of the sub-frame. Adjustment is made by hand-nuts *G*, right- and left-hand threads being employed. Four eccentric levers *H*, in conjunction with the clamps shown at *J*, are used for securing the jig to the frame. After the various members were riveted together, the holes were laid out, drilled and fitted with hardened bushings. This jig proved to be light and accurate.
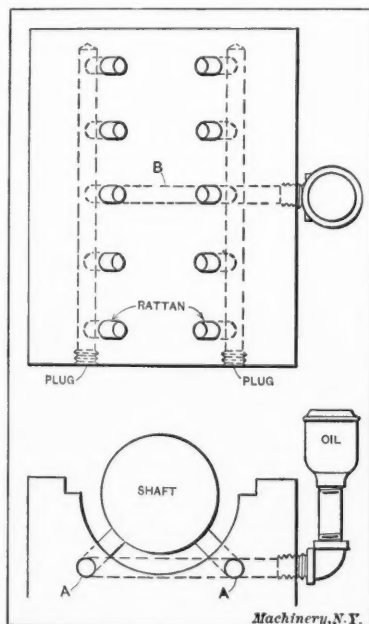
After experimenting with various styles of drilling machinery, the writer found an elbow bracket drill to be the most convenient and rapid.

Detroit, Mich.   J. F. RICHMAN.

SUPPORT FOR SHAFT WHEN BABBITTING

An excellent support for a shaft when babbitting, which may be used afterward for lubricating purposes, is made by inserting pieces of rattan in two rows of holes drilled in the casting, as shown in the accompanying illustration. The holes should be about ¼ inch in diameter, and the rattan cut long enough to support the shaft in the proper position. Two holes *A* should also be drilled lengthwise of the bearing to connect the bottoms of the holes in which the rattan pieces are inserted. The ends of these holes *A* are plugged as shown. After the babbitting is finished, a hole *B* should be drilled across the bearing to connect the oil cup with the supply channels *A*. When the shaft is in place and in motion, it draws the oil through the rattan pieces which wear eventually and which are always in contact with both the shaft and the oil in the supply channel below. This feeding action is due to capillary attraction combined with gravity.

S. C. SMITH.

Rattan Shaft Supports afterwards used for Lubricating

BORING MILL INTERNAL GEAR REPAIR

A 10-foot boring mill table with a broken internal gear is shown inverted in Fig. 1. This table is of cast iron, and the gear was cast integral with it. The breaking of this gear was caused by a broken tooth which jammed in the pinion, causing it to break out a section of the large gear at each revolution. As a new table would cost $385 in addition to a probable delay of several weeks, it was decided to repair the old one, and this was done in the following manner: A locomotive tire was found that would finish approximately to the correct size, and there was also stock enough for an inner flange for bolting the finished gear to the faceplate. A 15-

Fig. 1. The Boring Mill Table with its Broken Gear

inch Dill slotter with a table graduated into 360 degrees, was used to cut the teeth. As there were 120 teeth in the gear, the table was moved three degrees for each indexing. While the teeth were being cut, the tire was fastened to an old driving wheel center, to which it had been fitted in the same manner as it was to be held in position on the boring mill table. A recess about ½ inch deep was turned in the wheel center, and cap-scr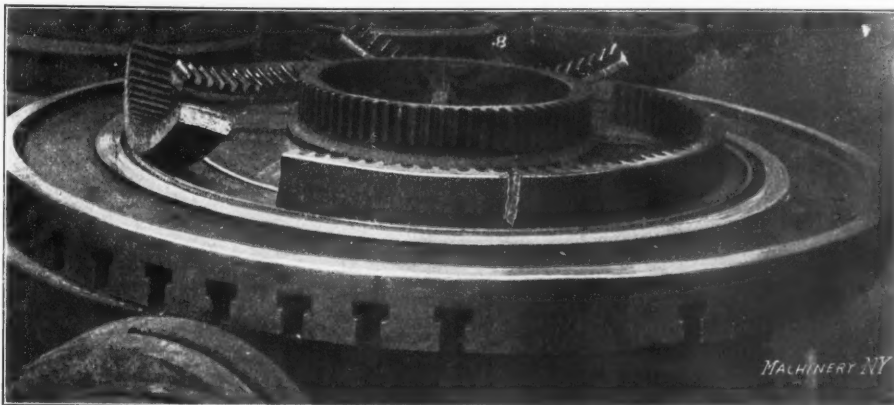ews were used to hold the work in place. The wheel center was also turned out on the under side to down over the outside of the slotter table. A roughing and finishing tool of the proper shape for the teeth was made to fit the slotter tool-bar, and the whole job was completed at a labor cost of less than $35. While this gear would probably not suit our friends, Mr. Grant or Mr. Bilgram, still it is doing the work for which it was intended, and is a fairly good job.

Battle Creek, Mich.   M. H. WESTBROOK.

SUGGESTION DEPARTMENT IN THE SHOP

I would like to learn what the opinions of some of the readers of MACHINERY are on the merits and demerits of a suggestion department in shops, such as many stores and manufacturing concerns have, where prize money is paid to employes for suggestions submitted by them and adopted by the concern, that will be of value. I think that it is a good
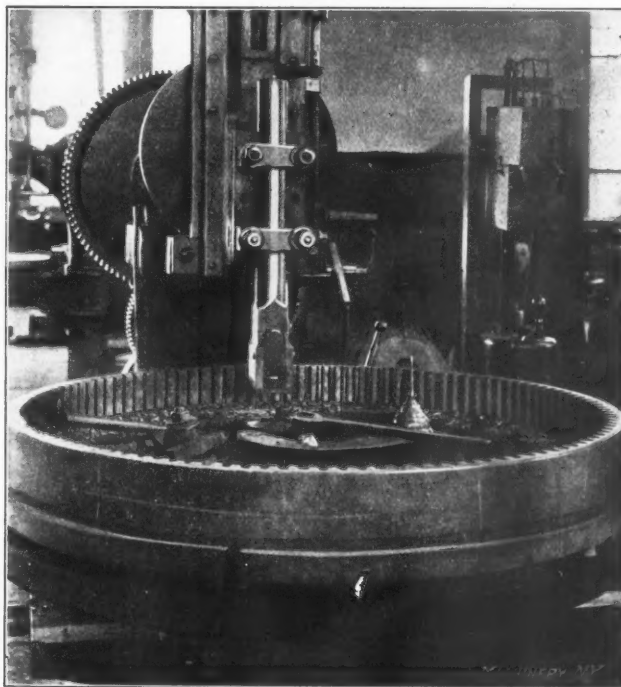

Fig. 2. New Gear being made from Old Locomotive Tire

thing if good sense and judgment are exercised in submitting the suggestions; and if conducted properly, it is an important factor toward the goal of commercial supremacy. I know of a number of highly prosperous concerns who acknowledge that much of their success is due to the suggestions submitted by their employes through the suggestion department.

Encouragement to employes from a concern for suggestions induces men to take an interest in their work and in the welfare of their employer. The ability of each man whose support is enlisted is also developed. Men engaged in a line of work day in and day out are often more likely to see the need of an improvement, than the foreman or superintendent.

When a suggestion is submitted by an employe through the suggestion department, he and not the foreman receives the credit for any improvement. A superintendent or foreman who is opposed to and refuses to accept or encourage suggestions from his men for improvements on a method or process, whether the suggestions come through a department or not, is, more than likely, impelled by jealousy and conceit and is burdened with an exaggerated sense of his own importance and ability. Obviously, such men should not be entrusted with important positions, as they are not qualified for the handling of men and the affairs of a concern. If a superintendent or foreman does not like to have it known that men under him can improve on his methods or system, it should spur him to so improve them that there will be no chance or room for suggestions.

Peoria, Ill. ARTHUR Z. WOLGAMOT.

LOCATING WORK WHEN BORING IN THE MILLING MACHINE

It often happens that accurate boring, drilling and reaming must be done on jigs, dies, fixtures, etc., in a milling machine, that cannot be relied on as to the accuracy of the measurement indicated by the adjusting screw dials because o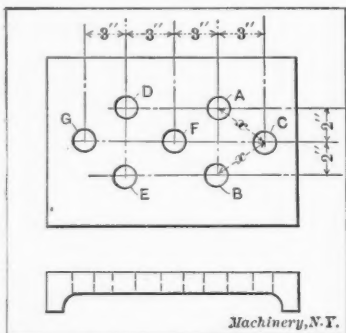f lost motion between the screw and the nut. By the following method, the most run-down milling machine can be used for such work, and accurate results secured.

Fig. 1. Jig-plate to be bored as indicated

A jig-plate is represented in Fig. 1 that is to be drilled and bored for jig bushings as indicated. This will serve to illustrate the method of setting work on a milling machine that cannot be relied on. It is assumed that the plate is finished on the edges, and that it is fastened to an angle-plate, which is secured to the table and set square with the spindle. A piece of cold rolled steel or brass is first fastened in the chuck (which is mounted on the spindle) and turned off to any diameter. This diameter should preferably be an even number of thousandths to make the calculations which are to
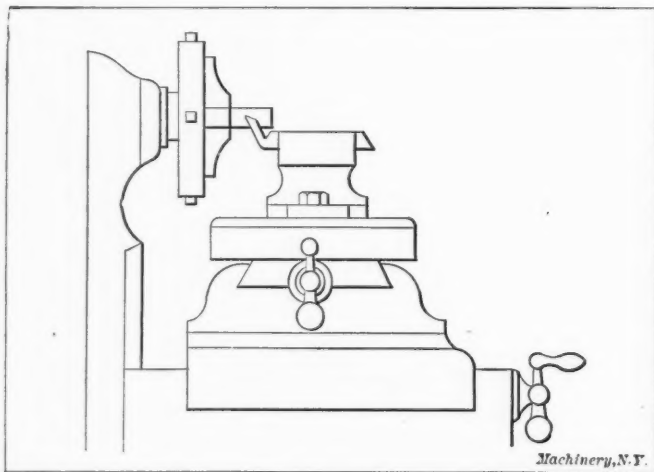

Fig. 2. Turning Plug used for Setting Jig-plate

follow, easier. The turning can be done either by holding the tool in the milling machine vise, as shown in Fig. 2, or by securing it to the carriage with clamps. In either case, the tool should be located near the end of the table, so as to be out of the way when not in use.

After the piece in the chuck is trued, the table and knee is adjusted until the center of the spindle is in alignment with the center of the first hole to be machined. This setting of the jig-plate is accomplished by measuring with a micrometer depth gage from the top and sides of the work to the turned plug as illustrated in Fig. 3. When taking these measurements,
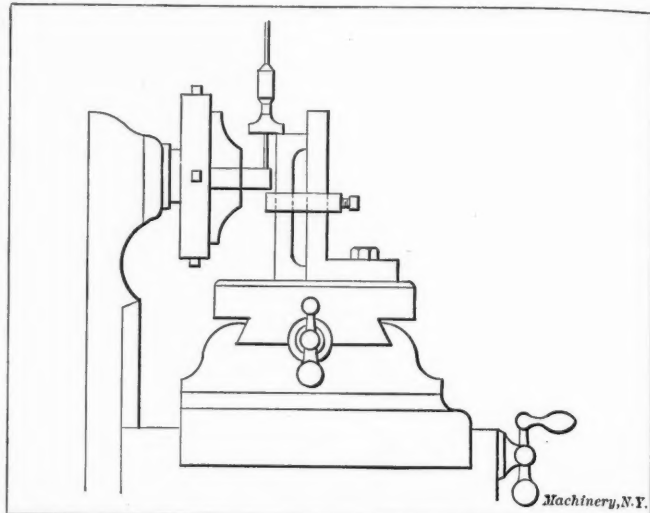

Fig. 3. Setting Jig-plate by measuring to Turned Plug with Depth Gage

one-half the diameter of the plug in the chuck is, of course, deducted. When the plug is properly set, it is removed from the chuck and the first hole A is drilled and bored or reamed to its proper size. The plug is then again inserted in the chuck and trued with the tool. After which it is placed in alignment with the second hole B; this is done by inserting an accurately fitting plug-gage in hole A and measuring from this gage to the turned piece in the chuck with an outside micrometer as in Fig. 4. Allowance is, of course, again made for the radii of the two plugs. The horizontal measurement can be taken from the side of the work with a
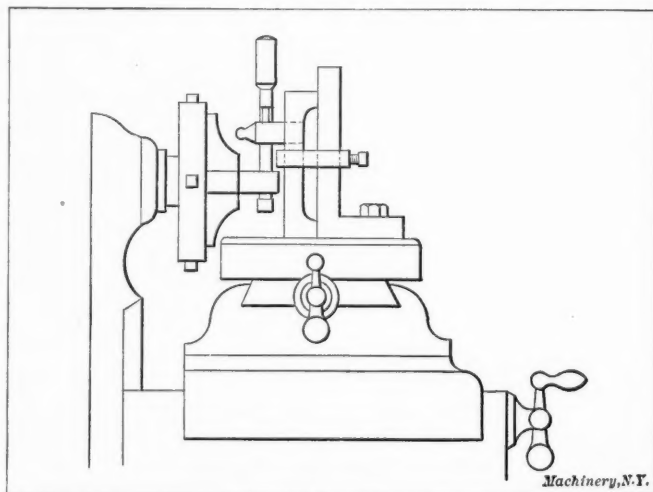

Fig. 4. Obtaining Accurate Center-to-center Distance by the Use of Plugs and Micrometer

depth gage as before. The plug is then removed and the hole drilled and bored to the proper size. Without changing the adjustment, the plug is again inserted in the chuck and turned true; the table is then moved vertically to a position midway between A and B, and then horizontally to the proper position for hole C as indicated by the depth gage from the side of the work. The location can be verified by measuring the center distances x with the micrometer. In a similar manner holes D, E, F and G are accurately located.

If the proper allowances are made for the variation in the size of the plug, which, of course, is made smaller each time it is trued, and if no mistakes are made in the calculations, this method is very accurate. Care should be taken to have the gibs on all sides fairly tight at the beginning, and these should not be tightened after each consecutive alignment as this generally throws the work out a few thousandths. If the reductions in the size of the plug, each time it is turned,

are confusing, separate pieces can be cut off and trued up to one side. If the center distances x are not given, it is, of course, far more convenient to make all the geometric calculations before starting to work.   L. E. KRAMER.

Newark, N. J.

MECHANICS' STETHOSCOPE OR SOUND TRANSMITTER

The engraving shows how a simple stethoscope or sound transmitter is made. Its use is adapted to small work and particularly to bench lathe boring, grinding or lapping. It is composed of a piece of ¼-inch rubber tubing with a hard rubber ear-piece and a conical brass cup with a thin steel disk for a diaphragm soldered to the large end. In addition, there is a spring clip fastened to the diaphragm with a screw. Suppose a small hole 0.015 inch in diameter is to be lapped;
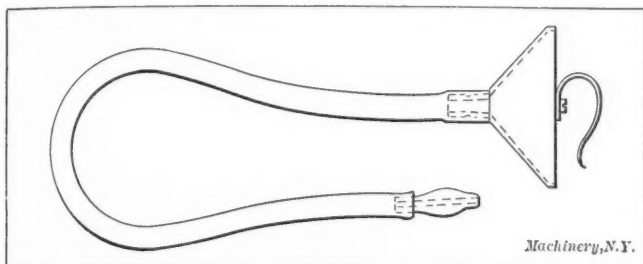

Simple Instrument for Transmitting Sound

then the spring clip on the diaphragm is slipped on the outside of the spindle bearing in which the lap is being used, and as soon as the lap is set in motion and adjusted, the finest touch can be detected with this instrument. I have seen many mechanics use the cover of a round tin box with a wire rod soldered to it. This transmits the sound fairly well, but the operator must hold his head in one position to listen, whereas the instrument shown in the sketch, because of the rubber tube, allows the operator to hear and also move so he can see what he is doing.   A. J. DeLILLE.

Elgin, Ill.

ADJUSTMENT FOR AUTOMATIC CENTER PUNCH

The following article describes an adjustment which may be fitted to a Brown & Sharpe plain automatic center punch. The advantages claimed for it are, a wider range of adjustment and the absence of projecting nuts on the ends of the
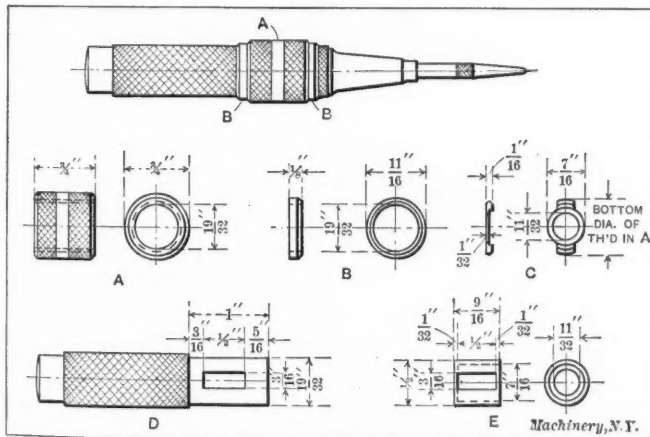
Parts for Making a Plain Automatic Center Punch Adjustable

punch. Its range of adjustment is from the full stroke of the punch down to no movement at all, as the release of the striking block is made adjustable, instead of the compression, on the spring.

At the top of the accompanying engraving the punch is shown assembled, and I do not think that it loses any of its neatness by the addition made to it. Parts A, B, and C are the extra parts required. The handle D is turned down on the end as shown, and two slots are cut through. Two slots of the same size are also cut in thimble E, so that when it is in position inside the handle, these slots are in line. Knurled sleeve A is bored to fit over the end of handle D, and it is

threaded inside, 16 threads per inch, V-thread. A nice smooth thread is required. Collars B, of which two are needed, are merely to keep sleeve A from screwing up on the knurled handle, as the shoulder is so small. Part C is made a nice sliding fit inside of thimble E, and the two projections pass through the slots in E and D. The ends of these projections are bevelled to fit the thread inside of A, so that, when the parts are assembled, and the sleeve A, which is fixed endways, is revolved, the part C moves up or down inside of E. The bore of part C is the same as the bore of the inside flange on thimble E, this flange releasing the striking block. It is obvious that by revolving sleeve A until part C is at the bottom, the center punch is practically solid. When part C is at the top, the stroke is practically the same as in the plain center punch, and any stroke between these limits can be obtained.   T. H. N.

SPECIAL BORING TOOL

We ran up against a snag at one time which made it necessary to design a special boring head and tool, and as the tool worked so satisfactorily I consider it entitled to a brief description in MACHINERY. This special tool was made necessary by a cored bearing which had to be bored, as there was no room around the shaft for babbitt. This shaft was fixed so that we could not get an end movement (or feed), and the bearing was also fixed, but we could drive the shaft by power when it was applied.
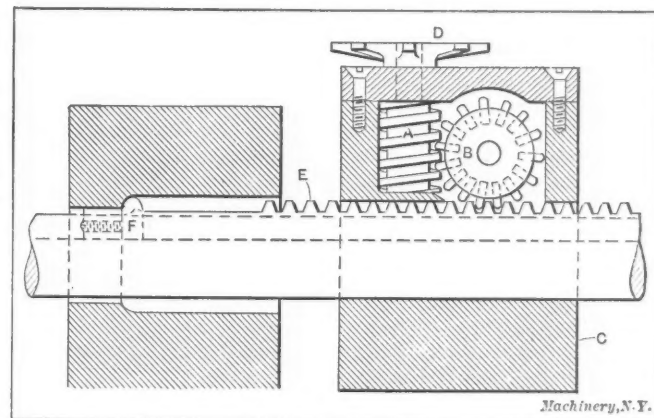
Special Boring Head and Tool

The accompanying illustration shows the construction of the special boring head used. It was made as cheaply as possible, and the parts were obtained from every available source. The worm A was taken from an old S-wrench, and the body C was made from a piece of scrap shafting. The cavity in which the worm A and wormwheel B were inserted, was cut with an end mill of practically the same diameter as the worm. This wormwheel was also made from a piece of scrap shaft, cut the right length to fit into the chamber. The teeth were formed by driving pieces of drill rod into holes drilled for the purpose. The part D is an eight-pointed star wheel, which was used for feeding the bar at each revolution of the shaft. The rack E was made from a piece of common key stock, of a size to fill the spline which happened to be in the shaft. The boring tool F was inserted in a hole in the end of the rack, and secured with a headless set-screw which allowed for adjustment. After the job was finished, it was found that by making two sets of brackets to support the ends of a permanent bar which was made to suit the head C, this tool could be used in many an out-of-the-way place, especially on repair work.   H. E. WOOD.

Newark, N. J.

MAKING ACCURATE AUTOMOBILE ENGINE PISTONS

In a large shop that was turning out a great number of automobile parts on contract, they had trouble in getting accurately finished pistons, and after trying several different plans, the following was found to be most satisfactory.

Fig. 1 represents a chuck which is made of two gray iron parts; namely, the body A and the closing ring B. The body

was screwed on the spindle of an engine lathe by a spanner wrench which engaged the holes C. Fig 2 represents the finished piston. These pistons after having been entirely machined, except grinding, were placed in this chuck and a fine finish cut was taken in the mouth. When the piston was placed in the chuck, closing ring B was screwed tight by a spanner wrench which engaged holes D. The ring being a good fit at H, remained true when drawn back by the threads; and as the chuck body A was beveled to match the
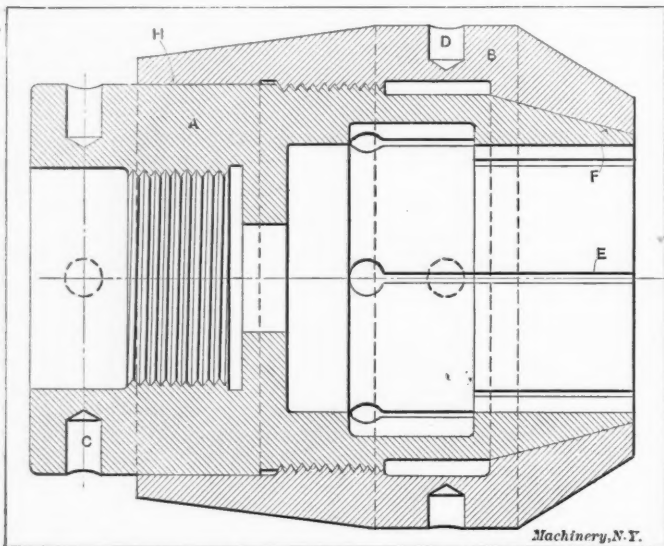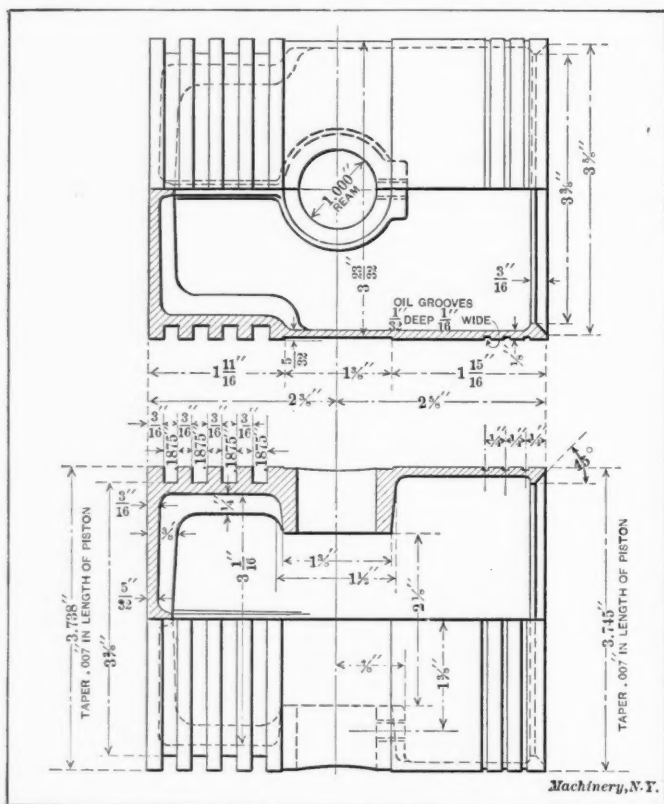

Fig. 1. Chuck for Holding Pistons while Boring Mouth

closing ring and saw-divided at E into three equal parts, it closed tightly on the piston and held it true so that the finish cut was true to the outside of the piston.

The cross bore in pistons which had previously been machined in a jig that fitted the outside diameter of the piston was, therefore, at right angles to the finished outside. Thus the cross bore, the mouth bore, and the outside diameter were made exactly true to each other. This much being accom-

Fig. 2. Automobile Engine on

plished, the finish grinding was made perfect by the mandrel shown in Fig. 3. This consists of a finished forging J, a pin K, that is a close fit in the cross bore of the piston and in forging J, and a cylindrical part L that is fitted accurately to the forging J and that also is a close fit at O in the finished

mouth of the piston. By tightening nut M, shoulder P is brought square against the end of the piston. It is now evident that with the piston center on one center of the grinder, and the centered end of forging J on the other grinder center, with pin N acting as a driver, that an accurately ground pis-

Fig. 3. Mandrel on which Pistons are held while being ground

ton would be the result. We found this method a little slower than some others, but the extreme accuracy obtained and the small number of pistons rejected by the inspectors, made the gain all in favor of the fixture.

<div align="right">JIG AND TOOL DESIGNER.</div>

HANDY SET OF CLAMPS

We had some work to clamp in a drill jig, and as the ordinary C-clamp required too much time to operate, the type of clamp shown in the accompanying illustration was designed. A common squared-head cap-screw with a dog point is used to

Machinery,N.Y.

Size No.	A	B	C	D	E	F	G	H	I	J	K	L
1	3	2¼	7⁄8	2¼	½	¾	9⁄16	1	1¼	3⁄8	3⁄8	5⁄16
2	3	2½	7⁄8	2½	½	¾	9⁄16	1	1¼	3⁄8	3⁄8	5⁄16
3	1⅞	1¼	¾	1⅜	½	½	9⁄16	1	1¼	3⁄8	3⁄8	5⁄16
4	2¼	1½	¾	2¼	½	¾	9⁄16	1	1¼	3⁄8	3⁄8	5⁄16

tighten the clamp after the movable side is swung into place. A ¼-inch pin, 3 inches long, passes through the head of the clamping screw, which makes it unnecessary to use a wrench for tightening. The swinging side of the clamp is pivoted to the main part by a pin which passes through a hinge fitting, as shown. Dimensions for four different sizes of clamps of this type are given in the table below the engraving. These clamps are very convenient, quick-acting, and they may be used for many purposes.

<div align="right">E. H. PRATT.</div>

DEEP HOLE CALIPERS

In response to the editor's request, in the December number, for descriptions of deep hole calipers, I submit the following and the accompanying sketch, as a possible solution of "J. W. M.'s" problem. Fig. 1 represents a point or inside caliper similar to those used in the U. S. arsenals on large gun work. The body of the caliper or "stick," as it is called in the shop, is made of a piece of wood, and the points A are made from wood screws, the heads being cut off and the body

turned down as shown. Two flat places are filed on each point so that a wrench may be applied to adjust the points in or out for any required size within its limits. These sticks have many advantages over the usual methods of obtaining inside measurements: They are easily adjusted to outside micrometers or verniers and it is only a few minutes' work to make one of any desired length; the wood acts as an insu-
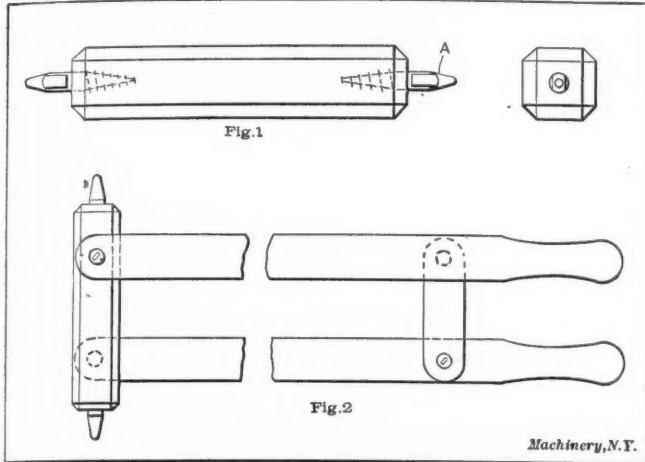

Figs. 1 and 2. Inside Caliper and Same Tool with Handles for Deep-hole Work

lation from the heat of the hand and furnishes a convenient place on which to mark the size to which it has been or is to be set in the inspection department. Fig. 2 shows how I would rig up one of these sticks to caliper the size at the bottom of a deep hole such as J. W. M. mentions, and with it I believe it would be an easy matter to ascertain the size within 0.00025 providing, of course, an outside micrometer of the required size is convenient. However, if the pieces are to be measured in large quantities, a star gage would be much quicker. T. COVEY.

DEEP HOLE CALIPERS

Through the "How and Why" page of the December, 1909, number of MACHINERY, J. W. M. asks for the best means of accurately determining the size at the bottom of a bore approximately 4 inches in diameter and 12 feet long. The best and cheapest way of measuring the diameter that I know of, is to take two wood screws, cut off the heads, point them,
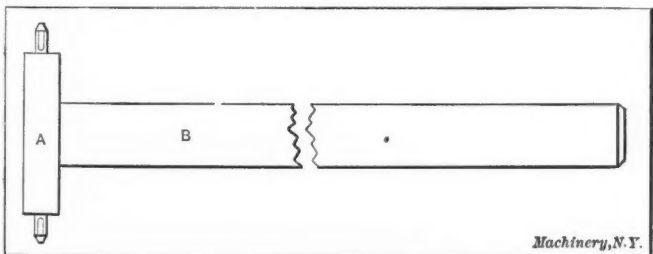
Improved Deep-hole Caliper

file a flat on each side of the body so that they can be turned with a wrench, and screw one in each end of a piece of wood A about ¾ inch square by 3 inches long. A wooden handle B of the required length should be attached to the center of the cross-piece A, thus forming a T. The flats on the screws make it easy to adjust them in or out until they are set to the diameter of the work. Of course, the caliper must be withdrawn each time an adjustment is made.

Poughkeepsie, N. Y. GEORGE H. DESROCHERS.

CENTERING A SHAFT WITH A MILLING CUTTER

The method of centering a shaft with a milling cutter when key-seating, described by Mr. H. E. Wood in the October number, is a very good one, and one that I have used many times. It is also a good way of centering work with the cutter when milling spirals. By this method the centers can be set central with the cutter before swinging the table to the angle of the spiral. Another good method of centering the cutter when milling spirals, is to set the pointer of a surface gage to the

height of the center, and then scribe a line across the end of the work, which is then indexed a quarter turn so as to bring the scribed line in a vertical position. The cutter may then be set with reference to this line. Still another method I often use when key-seating is as follows: The shaft is first adjusted so as to bring it within a few thousandths of being against the side of the cutter; then, if the cutter runs out laterally, it can easily be detected by sighting down over it while it is revolving. With the cross feed, the shaft is then set so that it just touches the side of the cutter. If the latter runs out of true, that part which is midway between the two points that run out the most should be set against the shaft. The dial on the screw is then set to zero; the table is locked, and the shaft is moved in a distance equal to one-half its diameter. The side of the cutter will then be in the same vertical plane as the center of the shaft. The dial may then be again set to zero so that the work may be moved a distance equal to one-half the cutter width. The shaft will then be exactly central with the cutter. ARTHUR Z. WOLGAMOT.

Peoria, Ill.

CLEANING AUTOMOBILES

As a foreman and mechanic in the automobile industry, I have been called upon many times to repair very dirty machines, a job which is sometimes annoying to the men. The device shown in the accompanying illustration has been found very effective for removing the dirt from automobiles, and it doubt-
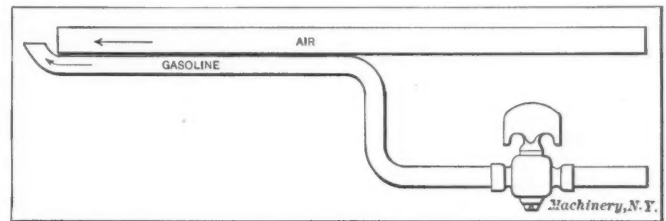
Air and Gasoline Nozzle used for Cleaning Automobiles

less would prove useful in connection with other work. This device consists of an air and gasoline nozzle, which is made of two pieces of tubing about fifteen inches in length. The sizes of these tubes are ⅜ and ¼ inch for the air and gasoline, respectively. Care should be taken to make the end of the gasoline pipe come exactly central with the air outlet, as shown in the illustration. By means of hose, one nozzle is connected with the compressed air and the other to a gasoline can. A valve can be placed on the gasoline pipe to regulate the amount of gasoline to be used. With a heavy air pressure, one gallon of gasoline will clean an entire automobile very effectively in an hour or so, and better than by any other method known to the writer. J. B. KEMP.

Indianapolis, Ind.

DIE FOR REDUCING MAGNETO CABLE ENDS

A handy fixture is shown below, which the writer had occasion to use for re-forming the spark-plug end of magneto cables used on automobile engines. Magnetos with cables were bought from one company, and after some time a change
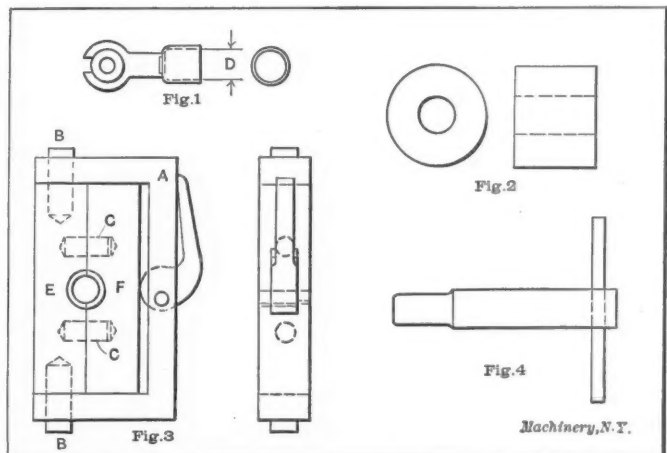
Figs. 1 to 4. Die for Reducing Spark-plug End of Magneto Cable and Sample of Work

was made in the cables and it was found that the new cables were 1/16 inch smaller in diameter. As a result, the terminal for the spark-plug end of the cable was too large and scraping this piece was out of the question, as this would involve considerable delay, which at the time could not be tolerated. In Fig. 1 is shown the cable end, the diameter D, being, as before stated, 1/16 inch larger than required. Fig. 3 shows the die for reducing the diameter. This die was split in order to be able to place the work into it. The part A of the die was pivoted on the pins B which were fastened into the half of the die marked E. The other half of the die was held by the eccentric which pivoted in A, the pins C locating this half. Fig. 4 shows the punch, and Fig. 2, a guide for the punch. This work was done by a boy, in a small hand press. After the piece was forced through the die and reduced, it was trimmed on the end, this being necessary because of the redrawing of the metal.

St. Louis, Mo. C. T. SCHAEFER.

EFFICIENT TYPES OF MILLING FIXTURES

With reference to **W. A. Sawyer's** "Efficient Type of Milling Fixture," illustrated and described in the October number of MACHINERY, in the Letters Upon Practical Subjects department, I would like to offer a little friendly criticism. I consider that there are at least three weak points in the design, *viz.*, (1) Work is not properly clamped. (2) Fixture is hard to keep clean. (3) Fixture is slow to operate.

To prove the claims—First, the work is clamped on one side of the cutter only and there is nothing to prevent the cutter from lifting the unsupported side at the beginning of the cut, unless the operator is very careful in advancing the work to the cutter. Again, if the work is not of a uniform thick-
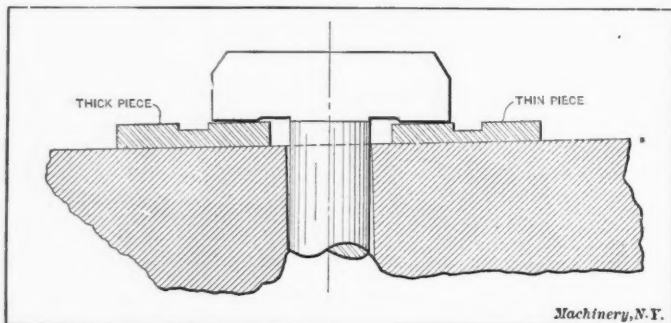
Fig. 1. Pieces of Different Thicknesses held by a T-clamp

ness, one piece will be clamped close to the cutter while the other is clamped at some distance from it. The engraving Fig. 1 will serve to illustrate this.

Second, to clean the fixture it must be taken apart, and this the writer considers a bad feature in fixture design, unless the construction is very simple. Any one studying Mr. Sawyer's design and noting the number of moves required to clean the fixture, will admit that the time required for cleaning is long compared with the time required to perform the cutting operation. I am, of course, assuming that Mr. Sawyer's sketch is proportional. The clearance slot for the pin C is unprotected from chips during the cleaning operation, and, in time, would become choked up. The foregoing objections would also apply to the third weak point, since it cuts down the output. It would be interesting to know what the latter would be per hour.

If a reliable vise is available, a pair of vise jaws could be made similar to Fig. 3 which would perform the operation satisfactorily. Jaw A, which is stationary, supports the work to within 1/32 of an inch of its width. B is a plain jaw. A slight angle of about ½ degree is given to the faces of both jaws to insure the work being held securely at the upper edge. A slight clearance check or groove is cut at C. D is a sliding pin which is an easy fit in both jaws. Into this pin is inserted pin E which locates the work. This pin is free to slide in jaw A, while slot F is protected from chips by means of a sheet metal piece G, which is dovetailed into A and slides with pin E. Clearance cuts J assist in lifting the work from the jaw. Lining pins H, which are driven into

jaw B and slide in jaw A, prevent any lifting effect when tightening the vise.

It will readily be seen that a design of this type will embody what the writer considers the five most important features in fixture design, *viz*: Simplicity, efficiency of clamping device, ease with which it is cleaned, quickness of operation, and durability. A design such as is suggested would not cost more than 25 per cent of the cost of Mr. Sawyer's fixture, and while it is only a single fixture, there is very little time saved in making it multiple, as the cut is comparatively short and shallow and the time saved by being able to remove work and brush away chips quickly will more
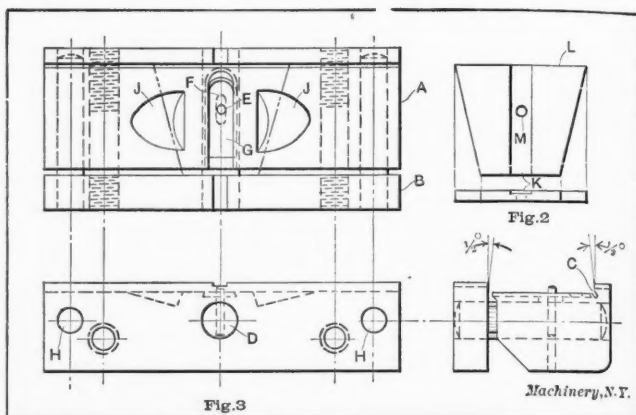
Figs. 2 and 3. Work and Fixture for Holding it while Groove "K" is being milled Square with Edge "L" and Central with Hole "M"

than counterbalance the advantage of milling two pieces at once; thus the output would be greater than with a fixture of Mr. Sawyer's design.

If a suitable vise is not available, a special vise with cam movement could be made at small cost to take a pair of jaws of the above type. The jaws can also be case-hardened and ground, thus adding greatly to their life. Where conditions will warrant the expense, and the output is increased, special fixtures are often advisable. Nevertheless there are many cases like the foregoing, where vise jaws will not only be cheaper but better in other ways.

Montreal, Canada. IRWIN JENKINSON.

TURNING A BICYCLE FORK

As the fork of my bicycle was broken, I tried one from an old wheel to see how it would fit, and found that it was suitable in every respect except the length of the stem, which needed to be cut off at A and be re-threaded. This work was done without difficulty by the following method: A block of
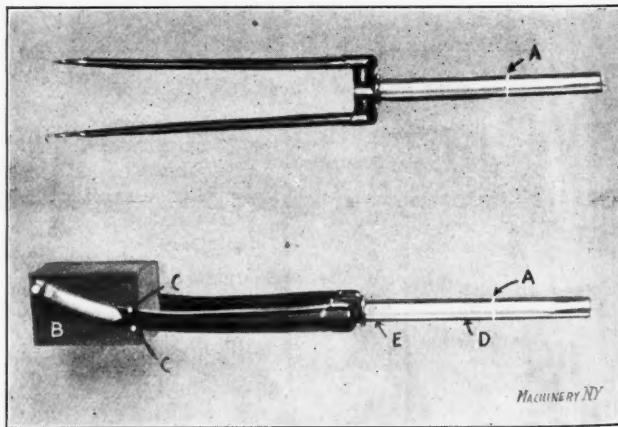
Bicycle Fork with Block fitted between Tines to permit turning in the Lathe

wood B was fitted in between the tines of the fork and was held rigidly by a bolt which passed through the tines and block. It was further secured by wire nails driven in at C. The fork was then placed in the lathe, the block of wood giving a good center for the live center of the lathe. After the steady-rest was placed at D the stem was easily cut off. The steady-rest was then changed to position E, the end of the work was supported by the dead center, and the thread cut, thus completing the job. STEPHEN COURTER.

Paterson, N. J.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

COLBURN "NEW MODEL" BORING AND TURNING MILLS

The Colburn Machine Tool Co., of Franklin, Pa., has developed a line of boring and turning mills, which we herewith
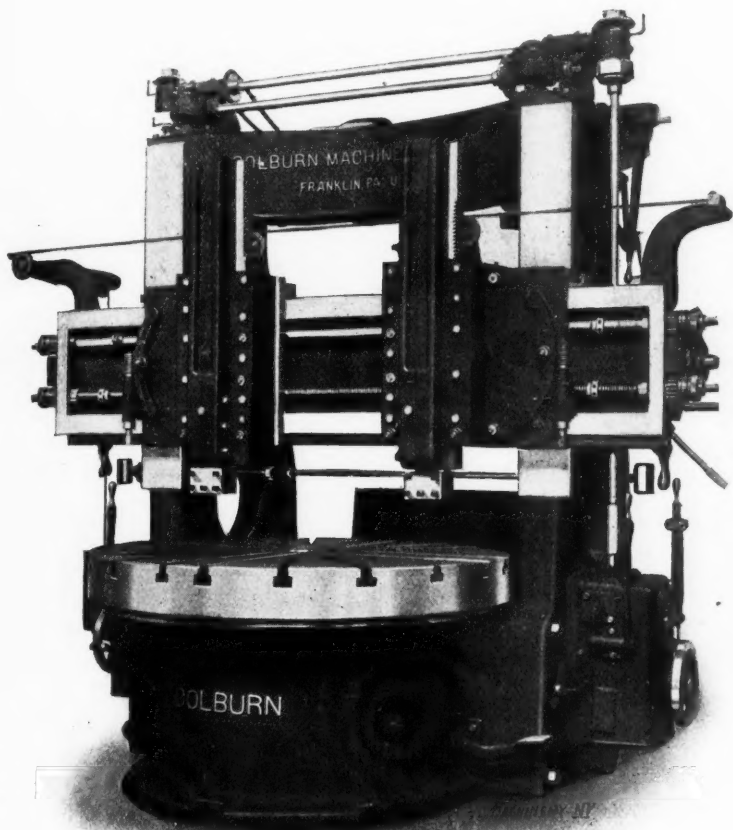

Fig. 1. "New Model" 60-inch Colburn Boring Mill

illustrate and describe. The name "New Model" is used to designate this design. In its general lines it does not differ from the older designs of the same builders but there have been important improvements in detail made throughout which materially increase its convenience and capacity. There are five sizes in the entire line, these being 42-, 48-, 50-, 60- and 72-inch swing, respectively. Practically the same features are incorporated in all the sizes, and a description of any one size applies to the rest. The illustrations here shown are mostly taken from the 60-inch machine.

The main framework of the machine is of standard construction as may be seen from the illustrations. The parts have been carefully designed to permit the taking of heavy cuts without vibration or deflections. The cross-rail, in particular, has been strengthened, having been given a heavy arched box section which is exceedingly rigid. The saddles have unusually liberal bearing surfaces on the cross-rail, with adjustable taper gibs to compensate for wear. The swivels, which are of large diameter and ample bearing area, are provided with an angular adjustment by means of a worm and gear, which also acts as a positive locking device making it impossible for the heads to accidentally fall over sideways when the clamping bolts are released. The ram (see A, Fig. 9) is very massive and has a steel rack set into its side. The cored opening is extended all the way to the top so that extra long boring-bars can be used. Clearance is provided to permit the rams to be raised within the guides.

The Main Spindle and Drive

Figs. 3 and 4 show clearly the construction of the spindle and the table drive. The spindle A has a massive angular thrust bearing which makes it self-centering. This, in conjunction with the two large cylindrical bearings D, effectually resists vertical, angular and horizontal strains. All these surfaces are lubricated from a common supply, this being the oil bath in which the angular bearing revolves. The lubricant is kept at the proper height by the oil gage and filler at the side of the base, connected to the spindle bearing by piping as shown in Fig. 3. The constant flow of oil along the conical thrust surface of A is maintained by the motion of the spindle. The lower part of the bearing is immersed in the reservoir of oil B, which is carried upward to the outer edge of the bearing and into the annular channel there, from which it is returned through suitable grooves to B again. By this means the bearing is automatically flushed, and the oil flows over into the cylindrical bearings. A circular safety pad of felt E contains enough oil to keep the cylindrical bearings D from becoming dry, even if the supplying of the reservoir is neglected for a long time.

The table is driven by a spur gear F of large diameter, attached directly to it. No lifting tendency is possible with this style of drive. As shown in Fig. 3, an internal gear is used on the 60- and 72-inch mills, while an external gear, as shown in Fig. 4, is used on the three smaller sizes. The table pinion G is mounted on a vertical shaft, which is oiled by a suitable reservoir and wicking as shown. In this case, as in the other important bearings, care is taken to provide a design which will give satisfactory lubrication, even though the oiler neglects the machine for continued periods.

The Speed Changing and Controlling Mechanism

The drive is by means of 5-step cone pulleys of large dimensions connected through a speed or back-gear box with the horizontal shaft carrying bevel gears
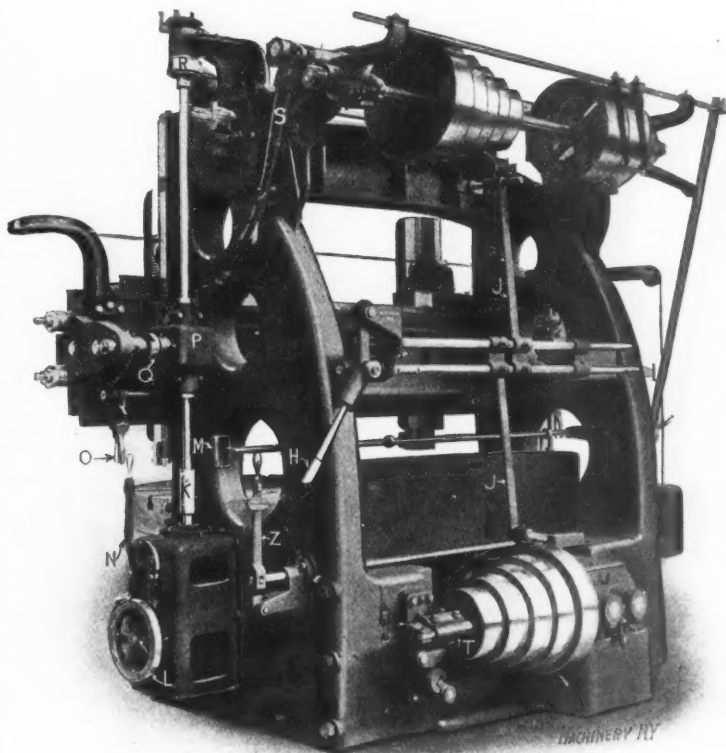

Fig. 2. Rear View of "New Model" Boring Mill, showing Main Drive, Controlling Handles, Levers, etc.

meshing with the vertical table pinion shaft shown in Fig. 4. The driving arrangement is best shown in Fig. 2, while details of the back-gear mechanism and the speed box are shown in Fig. 5. A belt shifter is shown which is simple, effective and easily operated, and avoids the necessity of the complicated mechanism and multiplicity of parts used on many geared speed-changing arrangements. By means of lever H (see Fig. 2) controlling belt shifters J, J, the belt can be changed from

Fig. 3. Details, showing Construction of the Spindle Bearing and Internal Gear Drive used on the 60- and 72-inch Mills

one step of the cone pulley to another with great rapidity and without any injury to the belt. In actual operation the change for the entire range of speeds given by the 5 steps in the cone pulleys has been obtained in eight seconds, going from the slowest to the fastest step and back again, and stopping momentarily at each speed.

The countershaft is attached directly to the upper parts of the housings by means of brackets having ring oiled bearings. It thus becomes a part of the machine itself. It carries the upper cone pulley and tight and loose pulleys. The loose pulley is provided with bronze bushings and is made smaller than the tight pulley, so that the strain of the belt is removed when the machine is not running. The machine may be controlled from either side of the mill by means of a horizontal rod connected with the shifter, having
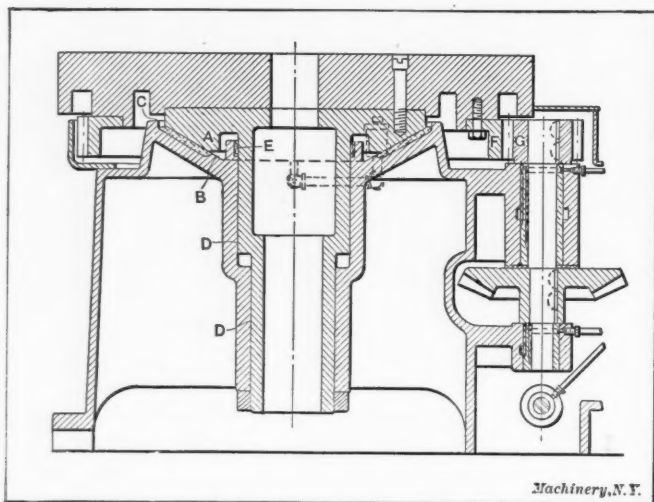

Fig. 4. Construction of the Taper Spindle Bearing and Provision for Oiling

a spade handle at each end. One of these handles is shown at M in Fig. 2.

The cone pulley is mounted on the driving shaft of the gear box, as shown in Fig. 2. This mechanism takes the place of the back-gearing ordinarily used. The speed change is made by gears and clutches which are constantly immersed

in a bath of oil. The slow speed is thrown out and in by means of lever Z, conveniently located at the side of the machine. This, with the five-step cone pulley, gives 10 speeds, all in geometrical progression.

The speed box, when assembled, is oil-tight, and the proper height of oil is shown at all times by the glass gage and oil filler on the outside. All the bearings are bushed with phosphor-bronze and are provided with ring oilers for additional protection. The oil runs into the oil box from the main reservoir. By removing the single plug under the oil feed cup, the entire box can be drained dry. At any time it is necessary to make repairs the mechanism can be removed from the machine in its entirety, so that every part is accessible.

A brake is furnished which enables the operator to stop the machine with the table in any desired position. It is operated by a foot-treadle placed within easy reach on the working side of the machine. This brake, as shown at B in Fig. 9, is provided with taper friction surfaces, formed with hard maple shoes and wedges. It is applied to the inside of the cone pulley, as seen at T in Fig. 2. The conical type of friction prevents any distortion of the bearings; since it is operated directly on the prime mover, all shock and jar is eliminated and the braking effect is practically instantaneous.

The Feed Mechanism

The feeding mechanism for each head is contained in a separate case, one on each side of the mill, permitting each to work independently of the other. By turning the hand-wheel L one revolution, five changes of feed are obtained. The further movement of the multiplying lever, projecting from the front of the gear-box in Figs. 1 and 3, permits hand-wheel L to be revolved and gives five more changes, making ten in all. The vertical feed shaft K, extending upward to the feed case, engages the mechanism on each end of the rail, which conveys
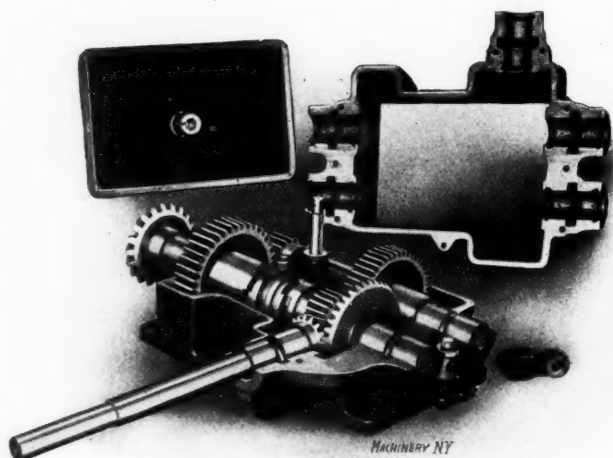

Fig. 5. Speed Box, showing Enclosed Mechanism and Ring Oiling Bearings

motion to the horizontal rods and screws in the cross-rail operating the heads horizontally, and vertically. The usual slip gears on the ends of the rods and screws are eliminated, and quick-adjusting positive clutches are substituted (see D in Fig. 9). This enables the operator to instantly change the feed from vertical to horizontal and *vice versa*.

Either feed can be reversed by lever O at each end of the rail which controls a clutch playing between a set of reversing bevel gears in box P. These gears are connected with the feed shafts through a safety shear pin device shown at Q in Fig. 2, and in detail in Fig. 6. At the left of the latter engraving it is shown in position, while at the right it is shown taken apart. The connecting shaft is made in two sections with little couplings on their ends, adjoining each other. The motion is transmitted from the driving member to the driven one by a small pin passing through each flange of the coupling. Any abnormal strain on the feeding mechanism in excess of that necessary on the heaviest cuts will

shear this pin off, and thus protect the mechanism from breakage.

When a pin shears, one-half of the coupling is turned half around until the slots are opposite the broken pins, which are then readily removed as shown at the right of Fig. 6. The couplings are then turned until the holes are in line again, when a new pin is inserted and the mill is ready to run. The whole operation of taking out the old pin and putting in a new one only takes a few seconds. There is nothing to adjust or to get out of order in the device. A supply of pins is sent out with each machine, but in case these are exhausted, new ones can be readily obtained, as they are made from the ordinary wire nails found around any shop.

Power Rapid Traverse

An important feature of this machine relates to the construction of the power rapid traverse. This is provided for all the movements of the tools, whether in a horizontal, vertical or angular direction. It is obtained from the same vertical
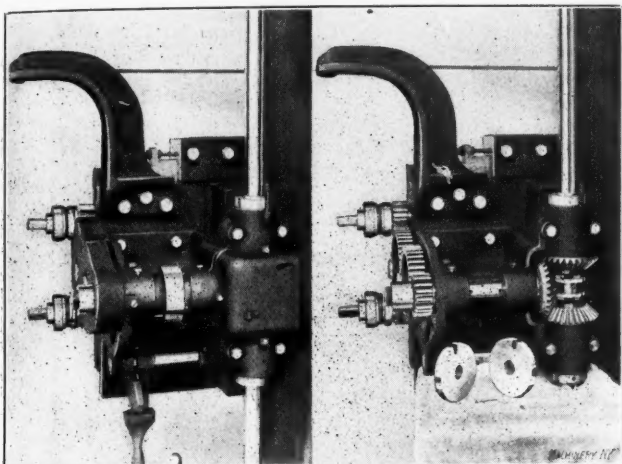
Fig. 6. The Safety Shear Pin Device for Protecting the Feed Mechanism, showing Ease of Replacing Shearing Pin

shaft K as the feed, and is controlled by the vertical lever N (see Fig. 2) at the side of the feed-box. This lever has two operating positions—either pulled in or pushed back. The regular gear feed is always engaged when the lever is in the back position, and if the feed is thrown in, the tool will then move in the direction determined by the position of the feed reverse lever O at the end of the cross-rail. On the other hand, the rapid traverse is always engaged and the gear feed is thrown out when the lever is in the forward position, and the tool will then travel rapidly in the opposite direction from that given by the gear feed.

It may take a word or two of explanation to show the advantage of this construction. It makes it impossible for
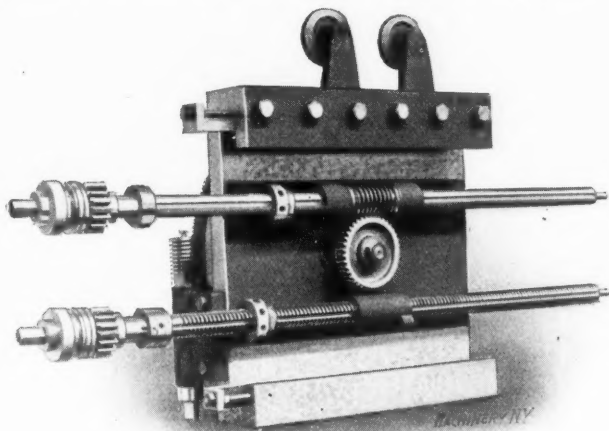
Fig. 7. Rear View of Saddle for Swivel Head, showing Large Diameter of Rods and Screws and the Fine Adjusting Collars for the Tool Movements

the operator to throw in the rapid traverse the wrong way, and thus avoids all chance of accident. For illustration, suppose the tool is feeding horizontally along the rail, taking a facing cut on a piece of work. Having reached the end of the cut, say with the tool up against the shoulder, the

operator desires to disengage the feed and return the tool to the starting point again for a finishing cut. He simply pulls the rapid traverse lever forward. No mental effort is required, and he does not have to stop to think for a second which way to pull it, as there is only one direction in which it can be moved. It makes no difference whether the tool
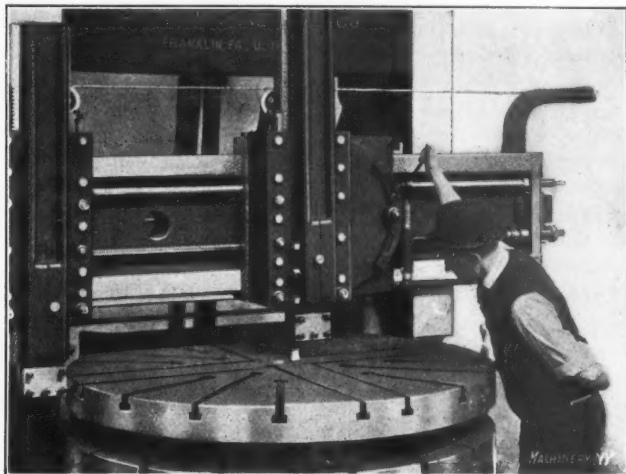

Fig. 8. Method of Making Minute Adjustments, which permits Close Observation of the Tool at the Same Time

is feeding to the right or to the left horizontally, or up and down vertically, the same lever controls the feed and rapid traverse in every case, and pulling the lever always throws the gear feed out and the rapid traverse in, at the same time reversing the direction of the travel of the tool. The rapid movement is obtained from the shaft at the top of the machine through vertical cones having cork inserts, of which one is shown at R in Fig. 2, and in detail at C in Fig. 9. This con-
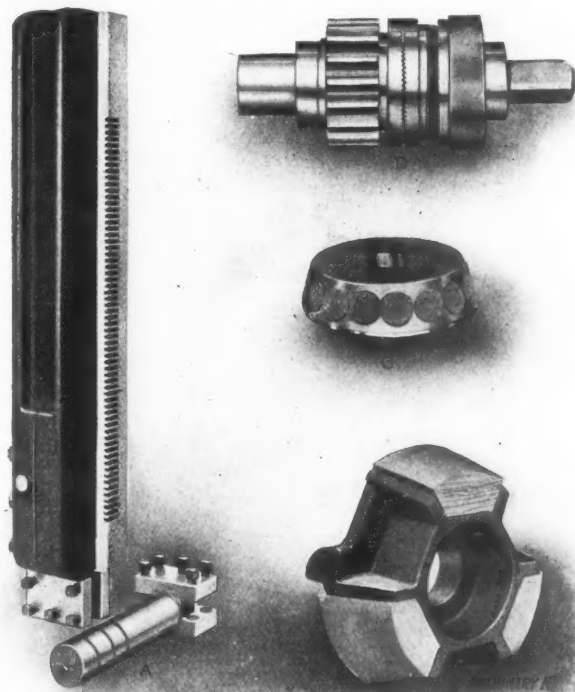

Fig. 9. Various Details. A—Ram. B—Brake Cone with Maple Shoes Treated with Paraffine. C—Cork Insert Clutch Member for Rapid Traverse. D—Quick-adjusting Clutch for Controlling Cross and Down Feeds

struction, which has proved its value in automobile design, does away with the necessity for flooded lubrication at this point.

The fine adjusting collar construction illustrated in Figs. 7 and 8, in connection with the rapid traverse just described, does away with the necessity for hand-cranking, although, of course, the ends of the shafts and screws in the cross-rail are squared so that a crank can be used in an emergency, or whenever the operator prefers. To permit the fine adjustment which the rapid traverse does not give, it has usually been necessary to go to the end of the cross-rail and use the

crank-handle. In this design, however, both the feed-screws and the rods in the cross-rail are splined and each has a capstan collar fitted thereto with keys, and free to slide on them. By turning the capstan collars with a small lever furnished for this purpose, the rods and screws are turned also.

The operator can stand close to his work, as shown in Fig. 8, and by placing the capstan collars in the most convenient position, he can make fine adjustments of the tools in any direction without having to go to the end of the rail where he could not readily observe the movement of the tool point. When the heads are moved to the extreme outer position on the cross-rail, these collars do not in any way interfere, as is apparent in Fig. 1, so that it is not necessary to make the rails any longer for the sake of having the fine adjustment.

Attachments and Extra Equipment

Another attachment not shown here, is provided for thread cutting. When this is used, the feed change wheel L is set to a predetermined point at which the table and vertical feed shaft revolve in unison. A single tooth clutch, connected with the rapid traverse lever N, is used for returning the tool quickly to its starting point; and when this is again thrown in to connect the mechanism for threading, the tool must always catch the thread. This is the familiar construction used on certain types of engine lathes in which the lead-screw and not the work is reversed for thread cutting. While the gear connection for threading is not furnished regularly it can be put on at any time. It is attached to the bracket at the end of the cross-rail, always on the right-hand head. The change gears provided allow all threads to be cut between 2 and 14 per inch. For drum scoring, special
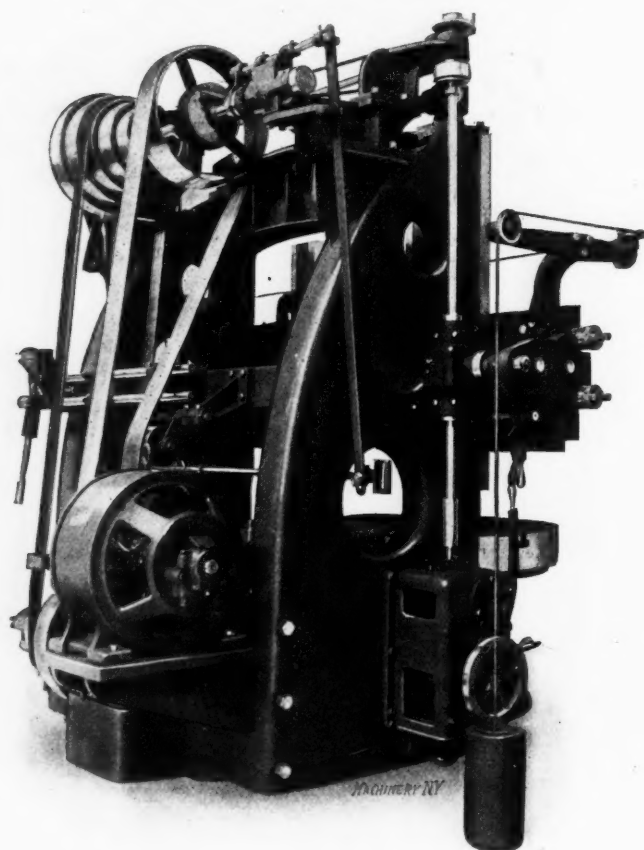
Fig. 10. Constant-speed Motor-drive for Colburn "New Model" Boring Mills

arrangements are made which allow leads as ccarse as one turn in 2 inches to be cut with the same facility as for the finer pitches.

The self-contained countershaft construction described in the beginning of the article particularly adapts the machine to motor-drive. The 5-step cone, mechanical belt shifter and the speed box, furnish a wide range of speed changes so that a constant speed motor is recommended. The motor is mounted, as shown in Fig. 10, on a bracket in the rear, and

is belted to a pulley on the countershaft. In order to enable the operator to stop or start the mill without stopping the motor, a clutch pulley replaces the regular tight and loose pulleys, and is operated by the same levers, with handles M (see Fig. 2) on both sides of the mill.

All the various features of design thus described apply to the whole line from the 42-inch to the 72-inch swing. There are some slight changes in the smaller sizes. As explained in connection with Figs. 3 and 4, for instance, an external spur
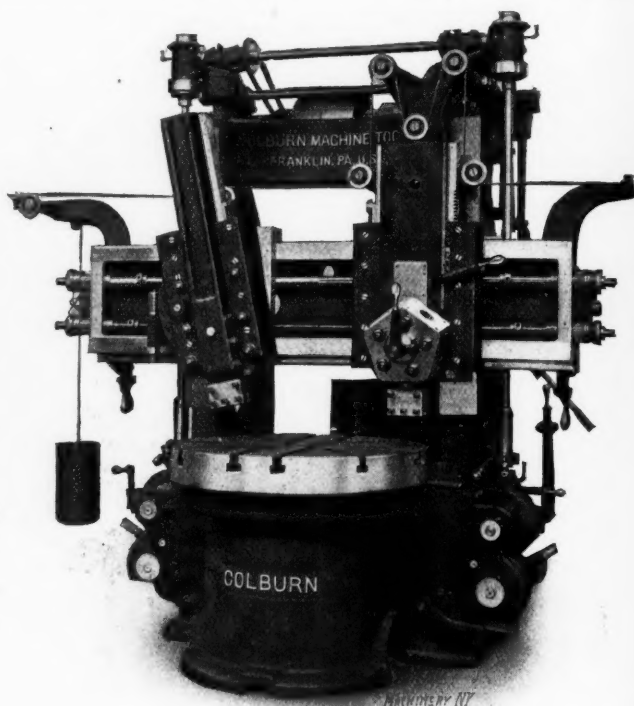

Fig. 11. The 42-inch Machine, showing Alternative Form of Feed Box and Turret on the Right-hand Head

gear is used for the table drive on the smaller sizes in place of an internal gear. Besides this the feed box is of different design on the 42-inch mill, as shown in Fig. 11. This change was made for the sake of securing compactness and to prevent the gear-box from extending out beyond the ends of the cross-rail where it would interfere with the movements of the operator. Turrets will be provided for the right-hand head, in the three smaller sizes if required by the purchaser. One of these is also shown in Fig. 11.

COX PIPE AND TUBE BENDING MACHINES

A series of pipe and tube bending machines is being brought out by J. Fillmore Cox & Co., Bayonne, N. J. These machines, of which one known as "Gem—Type B-No. 2" pipe and tube bending machine is shown in the illustration, embodying several interesting features, of which the most important is that the machine is capable of bending pipe and tubing cold, without the use of an inner filling, to any desired shape without injury to the metal in the pipe. Machines are being built that will take sizes from ⅛-inch tube up to the largest size which is likely to be required to be bent. The machine is, in many respects, a radical departure from previous designs of pipe bending machines, and in view of the rather crude and expensive methods and devices used in many places for bending pipe, it will undoubtedly prove of value to manufacturers who have a great deal of pipe bending to do. When bending pipes, a special collapsible plug is used in connection with a patented flexible chain operating the mandrel. The pipe is bent around rollers with specially shaped grooves, and levers are provided for certain operations with graduated adjustment for setting the bending rollers, so that certain predetermined bends will be produced.

The machine is gear-driven, and a "twin pinion" system of gearing has been incorporated which prevents any possible chance of backlash or lost motion, so that at all times a steady power is obtained, which is not generally possible with

other methods. An automatic stop arrangement is provided by means of which it is possible to obtain exact duplications of bends. A safety stop is also provided for the power mechanism. The main vertical shaft has been made of heavy dimensions so as to be able to easily withstand the heavy stresses to which it is subjected when in operation. In cases where a great number of pipes are to be bent in the same way, they may be cut to the same length and placed in a
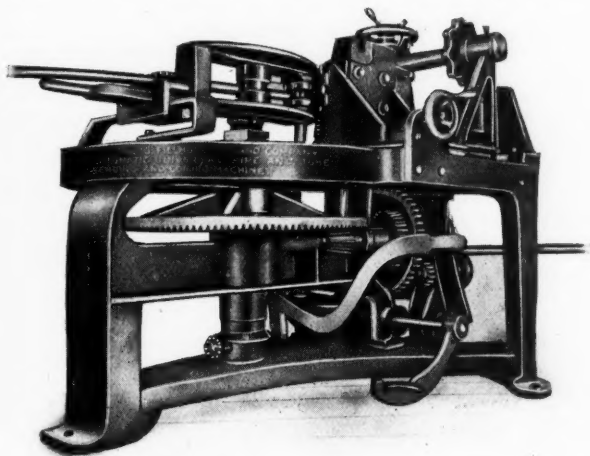
Pipe Bending Machine, built by J. Fillmore Cox & Co., Bayonne, N. J.

magazine attachment from which they are fed gradually to the working mechanism. Radial bends, for instance, may be automatically made when the magazine attachment is provided. Such bends as a conical helix and regular helical coils may be performed on this machine by the use of special attachments. Outside of its application to the bending of pipes, the machine may also be used for other kinds of bending, such as the bending of steel rails, angle irons and other structural shapes.

ROCKFORD MULTIPLE SPINDLE DRILLS

We have previously described the sensitive drills both of the floor and bench types made by the Rockford Lathe & Drill
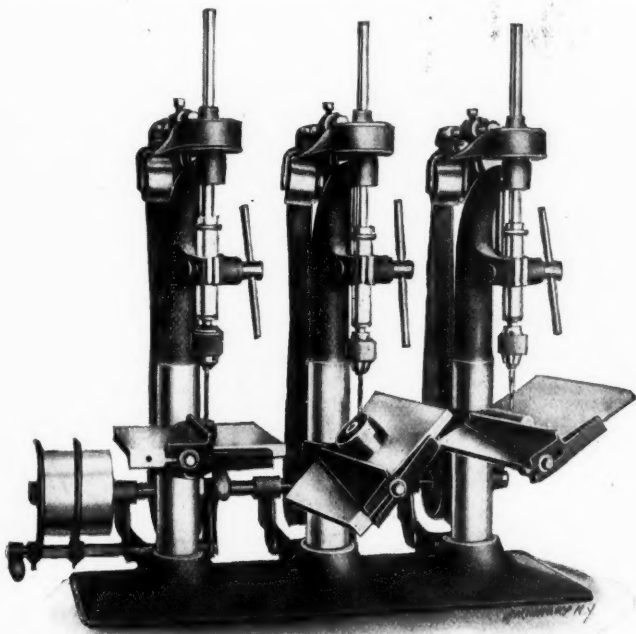
Fig. 1. Rockford Three-spindle Bench Drill, showing Use of Tilting Table and Adjustable Gage

Co., of Rockford, Ill. Both of these machines can now be furnished in the multiple spindle type as shown herewith. All the advantages of the single spindle machines are retained and a number of new features of design are added.

Fig. 2 shows the floor type of multiple spindle drill. The single spindle machine was first illustrated and described in the June, 1908, number of MACHINERY, under the old firm

name of "Rockford Machine & Shuttle Co. As may be seen, the tool is provided with a substantial base and column, carrying, in the case shown, four spindle heads. It will be furnished as a two- or three-spindle machine when desired. Among the points that should be noticed is the self-contained countershaft with tight and loose pulley and convenient belt shifter. The work-table is adjustable for height, being counterbalanced inside the column. Another important improvement consists in mounting this table on a three-point adjustable bearing, making it possible to keep its surface in alignment with the spindle under all conditions. The two outer supports are adjustable by the threaded studs and nuts shown. Belt guards are provided for the spindle-driving pulley. The stop collars for the depth of the drilling are mounted on the upper ends of the spindle as shown.

The bench machine shown in Fig. 1 was illustrated as a single spindle machine in the New Tools department of the
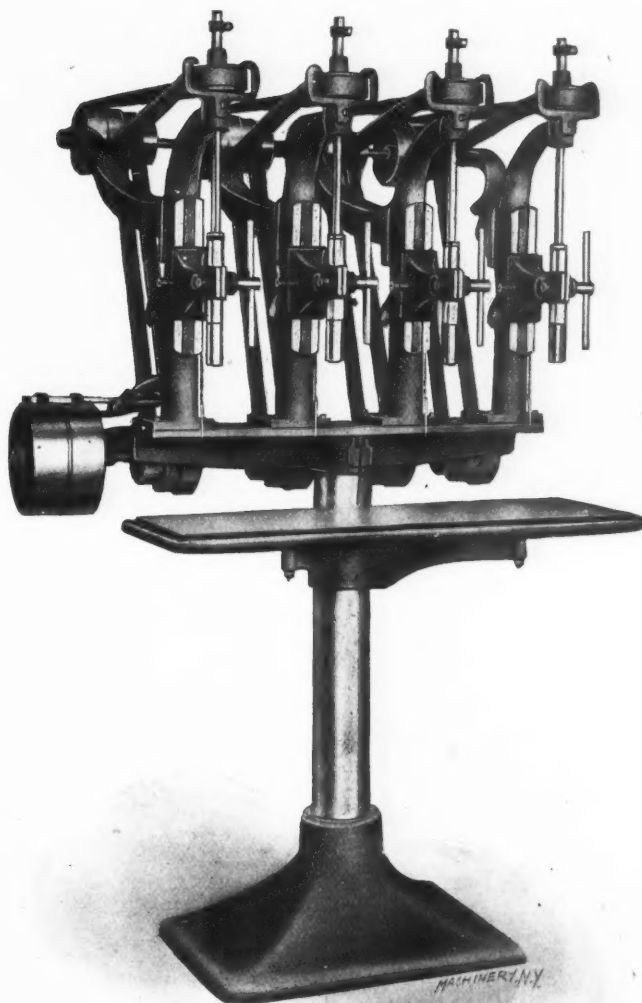

Fig. 2. Four-spindle Floor Type of Drill

November, 1909, issue of MACHINERY. In this case, also, a self-contained countershaft with a convenient belt-shifter is provided. A two-step cone for each spindle is mounted on the countershaft from which the belt is led over the tightener pulleys to the spindle driving pulley above, permitting the separate spindles to be given speeds appropriate to the diameter of hole drilled. The machine will work to the center of a 10-inch circle. The stop for depth is located in this case on the spindle sleeve.

Fig. 1 illustrates very plainly the usefulness of one of the special features of this make of drills. The work-table can be swung around the column to any point desired, or can be turned, as shown in the case of the central and right-hand heads, to any desired angle about a horizontal axis. The usefulness of this adjustment is increased by the provision of a squared block or gage, which may be adjustably clamped to the table as shown. Reading from the left, in the first case

this is being used simply to locate a block so that the hole will be drilled at the desired distance from the edge. In the second case this gage is used to support a pulley while an oil or set-screw hole is drilled at an angle, the table being tilted for this purpose. In the third case the gage, in conjunction with the surface of the table, provides a V-block for drilling holes into round work. The use of this device makes it unnecessary to rig up temporary holding contrivances out of blocking, bolts, clamps, etc., and greatly increases the range of the machine.

MOTOR-DRIVEN AVEY SENSITIVE DRILL PRESS

A sensitive drill press made by the Cincinnati Pulley Machinery Co., Cincinnati, Ohio, was illustrated and described in the February, 1909, issue of MACHINERY. The machine then illustrated was provided with loose and fast pulleys and was intended to be driven from a countershaft. In the accompanying engraving the same machine is shown provided with individual motor drive, the motor being
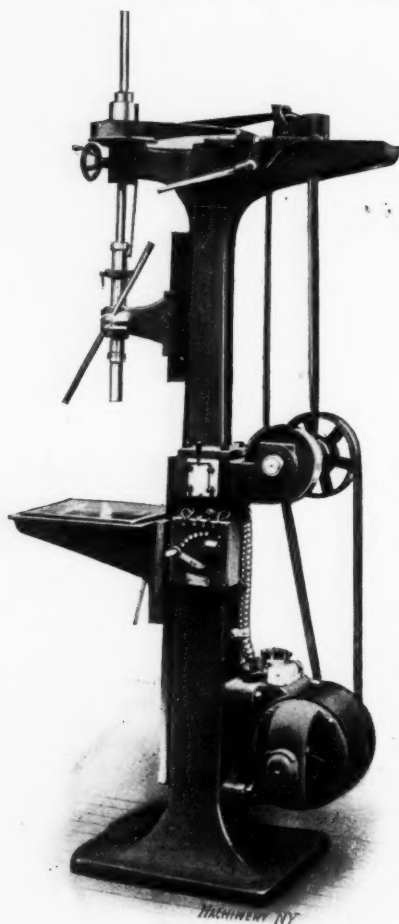
Avey Motor-driven Sensitive Drill Press, built by the Cincinnati Pulley Machinery Co.

mounted on a bracket on the lower part of the column and driving the intermediate cone pulley shaft by means of belting. The starting box is placed on the side of the column, as shown. This arrangement is very simple and compact, and makes it possible to apply motor drives to these drill presses when required without making any change in the general design of the machine. The bracket on which the motor is mounted has vertical adjustment on the column so that proper belt tension can be secured at all times. The motor shown in the illustration is a General Electric ½-horse-power motor.

It will be recalled from the previous description of this machine that the particular feature of it is the driving arrangement. Of additional features may be mentioned that it runs on ball bearings throughout, and has a graduated spindle sleeve with a stop collet having a clamp screw which requires no wrench or screw-driver; the graduated spindle sleeve makes scale measurements for depth of holes unnecessary. The spindle has a motion of 13½ inches, and a rack feed of 6 inches. The maximum distance of the spindle from the table is 35½ inches. While the drill is shown in the illustration as a single spindle machine, it may be provided with two, three and four spindles on the same base column, if required. The machine has a capacity for using drills pro-

vided with a No. 2 Morse taper, the largest diameter of drills with this taper being 29/32 inch.

BARNES HORIZONTAL RADIAL DRILL WITH FOUR HEADS

A horizontal radial drill built by the W. F. & John Barnes Co., 231 Ruby Street, Rockford, Ill., was illustrated and described in the December, 1908, issue of MACHINERY. This type of drilling machine has been found especially valuable for boring jigs, as the horizontal table is much better adapted for holding large irregular castings than is the vertical angle plate. The accompanying illustration shows a special machine of this type recently brought out by the company. This machine is provided with four heads, as shown, one on each side of the table. Each of the heads is of the same design and construction as the head used with the regular No. 3 horizontal radial drill, the special part being the table which has a top 30 inches square. The machine was built especially for boring, tapping, and other operations on a casting containing two different sized holes on each of its four sides. By having four heads working at once, the casting can be strapped to the table and left in this position while the heads which are adjustable both vertically and radially can be set so that the spindles come into proper positions to perform the operations required on the casting. It is readily seen that a large range of work can in this way be taken care of by machines designed with two or more heads mounted on the same table. The manufacturers often furnish the heads only, the customers making their own base or table to suit
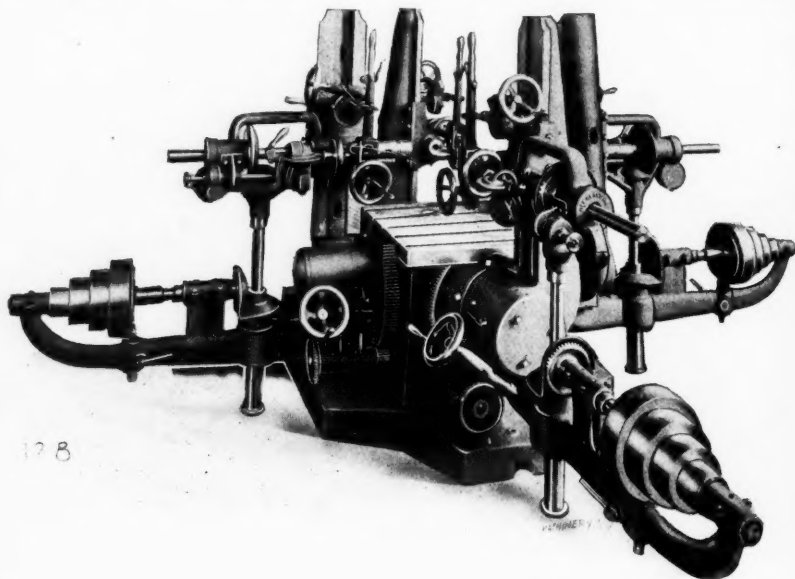
Horizontal Radial Drill, made by the W. F. & John Barnes Co, Rockford, Ill.

various requirements. The total weight of the machine shown in the accompanying illustration is 9,000 pounds.

As will be recalled from the previous description of the regular machine, the spindle is capable of all the movements and adjustments of a regular radial drill, but it has its spindle horizontal instead of vertical. The only adjustment which is not provided is that corresponding to the raising and lowering of the radial arm which, however, is not required, owing to the fact that the horizontal table allows the work to be clamped in any position relative to the spindle so that in this way the vertical adjustment of the arm in the ordinary radial drill is taken care of. The maximum distance from the table to the centers of the spindles is 29½ inches, the minimum being 2⅜ inches. The spindle which is provided with a No. 5 Morse taper hole has a horizontal travel of 18 inches. The drilling capacity is up to 3-inch holes in cast iron and 2-inch holes in steel, with a tapping capacity of 3-inch regular, and 2½-inch pipe taps.

The increasing tendency to use special machinery for operations which can be more rapidly handled in machines especially adapted for the purpose, will doubtless make machines of this type popular with manufacturers of interchangeable machine parts.

TOLEDO PRESSES OF UNUSUAL SIZES

The accompanying illustrations, Figs. 1 and 2, show two powerful presses of unusual dimensions recently designed and built by the Toledo Machine & Tool Co., Toledo, Ohio. These
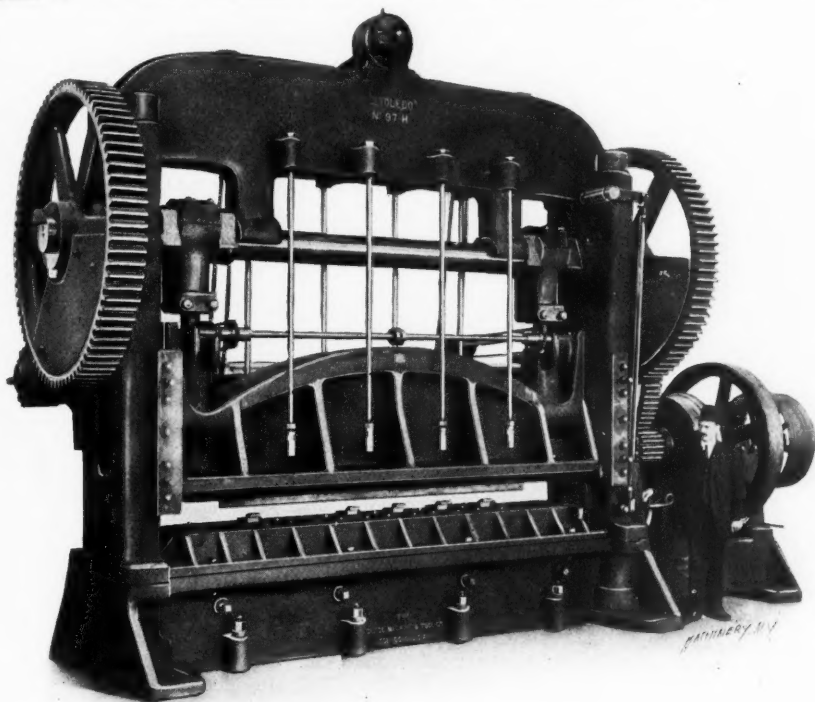
As the illustration shows a front view of the machine, this clutch is, therefore, not in view. The lever and segment by means of which it is controlled, however, is shown to the right in the illustration, directly beneath the man's hand.

Some of the more important dimensions and weight of the machine are as follows: The stroke or slide motion is 8 inches; the ratio of the gearing is 40 to 1; the size of the main gears is 86 inches diameter by 10 inches face. The width between the housings is 14 feet 4 inches, and the height from the floor line to the top, 15 feet, the bed extending 2 feet below the floor line. The floor space required over all is 9 feet 4 inches by 25 feet 10 inches. The power required for operating the press is 40 horse-power, and the total weight of the press as illustrated is 185,000 pounds.

Fig. 1. Large Press for Automobile Frame Work, built by the Toledo Machine & Tool Co., Toledo, O.

presses are constructed for cutting and forming the steel bodies and frames for automobiles. The press in Fig. 1 is intended for pressing up or forming the side and cross channels for the lower or under frame. This work has formerly been done on hydraulic presses, but the best results obtainable may be produced by the use of the press illustrated. In the illustration, the dies are shown in position for performing the work. The lower die is fitted with a pressure attachment, having a capacity for exerting a pressure of about 500 tons. This prevents the distortion of the strip while being formed. The press itself has a capacity or ram pressure of nearly 900 tons. It operates at the rate of eight strokes per minute.

As shown in the illustration, the press is fitted with twin gears on the crankshaft. Engaging with these gears are two pinions on the heavy pinion shaft driven through gearing from the main driving shaft. A powerful friction clutch with hand lever control is provided between the driving pulleys and the gearing, giving the operator complete control of the press stroke at all points. An interesting feature in connection with the press is the motor-driven elevating attachment for adjusting the slide, this being required on account of the size and weight of the sliding parts. This attachment is operated by a four horse-power motor mounted on the top of the frame arch, as shown in the engraving. The power is transmitted down to a rear shaft, by means of sprockets and link belts, and from there is carried over to the worm shafts, on which are mounted worms engaging with wormwheels on each of the right- and left-hand pitman screws. This arrangement is plainly shown in the engraving. A reversible friction clutch is provided for this attachment, just below the motor, and is attached to the rear of the arch.

In Fig. 2 is shown a machine designed for pressing the parts for automobile bodies, including the seats and panels for touring car bodies. An unusual distance from the bed to the slide is consequently provided, in order to accommodate the dies necessary for pressing up large steel backs and seats. A stroke of 24 inches is necessary for this purpose. An additional sub-base or bed is attached to the top of the main bed of the machine. This sub-base is not shown in the illustration. It is 40 inches high, and when in position reduces the height or distance between the bed and the slide to what would ordinarily be required for regular work. The bed-plate or bolster which is used on the main bed of the press will fit on the sub-base also. The same applies to the drawing attachment which is used in connection with the bed for operating the drawing and forming dies necessary for this class of work. These attachments are made removable and may be changed from one bed to the other, in a reasonably short length of time. The machine is provided
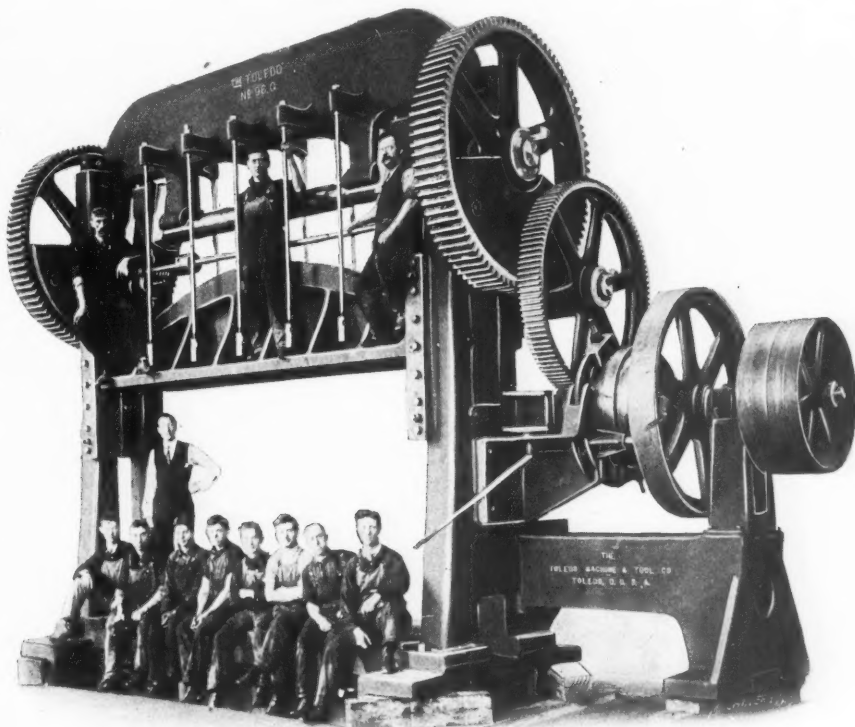

Fig. 2. Toledo Press for Automobile Body Parts

with clutch arrangement and gearing similar to the press previously described.

The main dimensions and weight of the press are as follows: The ratio of the gearing is 45 to 1, the number strokes per minute being 6. The width between the housings

is 12 feet 4 inches and the total height above the floor line is 16 feet. The bed extends 40 inches below the floor line. The floor space required is 8 feet 4 inches by 23 feet 4 inches. The total weight of the press is 165,000 pounds.

ROWBOTTOM CAM CUTTING MACHINE

The Rowbottom Machine Co., of Waterville, Conn., is building the cam cutting machine shown herewith. Among other interesting features this machine has the advantage of being universal—that is to say, it will cut plate and face cams, or barrel cams, without requiring the use of attachments or separate heads. It is also provided with unusually convenient adjustments which increase its adaptability for difficult work, as will be explained.

The machine comprises, primarily, a rigid bed on which are mounted a head for the master cam H, a swiveling work-
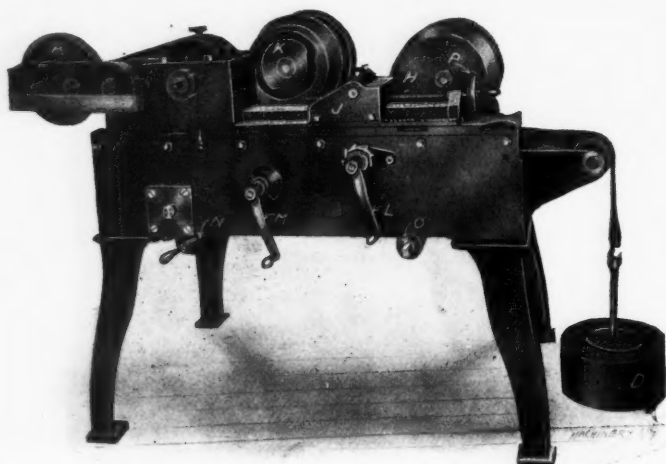
Fig. 1. The Rowbottom Universal Cam Cutting Machine

head F for the cam K being cut, and a slide on which is mounted the cutter spindle and its driving mechanism and the adjustable bracket J for the master cam roll. The master cam spindle and the work-spindle are fixed in place in the bed and revolve together with the feed mechanism. The master cam roll and the cutter spindle, being mounted on the same slide, receive motion from the master cam, which thus gives an appropriate form to the cut taken in the work. The weight D connected to the slide holds the follower roll against the master cam.
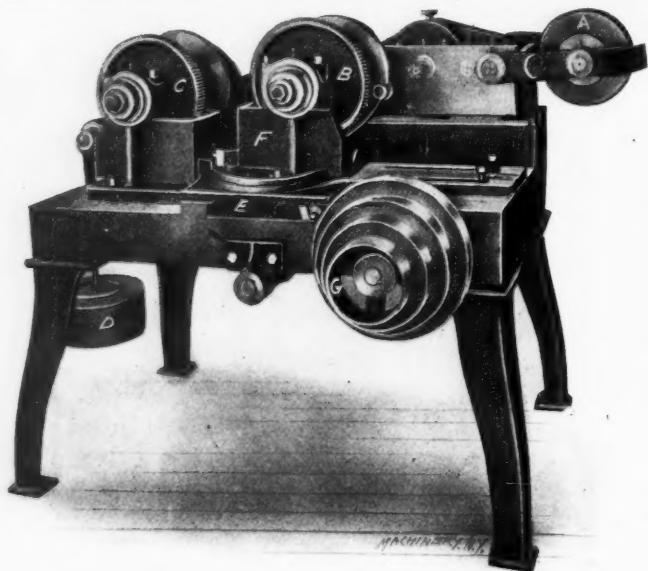
Fig. 2. Driving Side of Machine, showing Adjustment of Follow Roll Bracket on Cutter Slide

The spindle is driven by pulley A, which is mounted on a pivoted yoke. The pulley and the gearing contained in this yoke are heavy enough so as to keep the driving belt tightened to the proper degree throughout the movement of the slide, under the influence of the master cam. The gear-box,

which is shown with cover removed, provides two changes of speed. This with the two on the double driving pulley A, gives four in all. All the gearing in the gear-box runs in an oil bath.

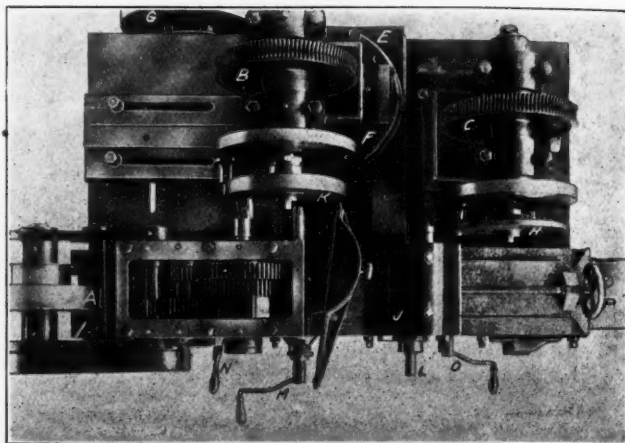The rotation of the master cam and work-spindles is effected through cone pulley G, which is connected by gearing with

Fig. 3. Machine set up for Cutting Face and Plate Cams

worms meshing with worm-wheels B and C. Lever N controls this automatic feed, throwing it in or out. When it is thrown out, it may be operated by hand by placing the crank on feed shaft O. The handle on M operates the cross-slide screw by means of which the work-slide E, carrying the swivel work-head F, is fed in toward the cutter to give the required depth of cut. This adjustment is provided with a micrometer dial. By placing a crank on shaft L the slide carrying the former roll and the cutter spindle can be rapidly
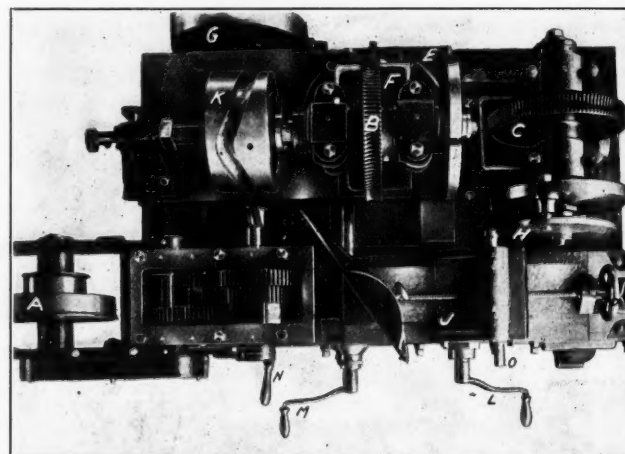

Fig. 4. Machine set up for Cutting Barrel Cams

drawn back against the tension of weight D for the purpose of inspection, removal of work, etc.; this movement is effected by a pinion on the shaft engaging the rack on the under side of the cutter slide. The ratchet shown on shaft L serves to support the slide in this position against the pressure of the weight. This ratchet has, of course, to be raised to allow the former roll to come back to its bearing on the cam. When ready to start, the pawl is thrown back from the ratchet, allowing the weight to be brought back into contact with the former roll and the periphery of the cam.

The particular construction of the machine, as described, offers certain advantages which are best seen from an inspection of Figs. 3 and 4. The master cam is always of the plate variety. This means that it is made in the least expensive way and in the way which permits the greatest accuracy. It is only the work-head F which is altered to permit the cutting of plate, face and barrel cams as may be required. This change from face to barrel cams, as has been explained, is done without the use of attachments of any kind, it being only necessary to swivel the head around at right angles. It is shown in the two positions in Figs. 3 and 4. This construction also fits the machine for cams cut on conical surfaces—a construction met with once in a great while. For

this work the head is simply swiveled to the angle required by the cone on which the cam is to be cut.

Another exceedingly useful adjustment is that of the former roll bracket *J* along the cutter-slide. This is controlled by a screw operated by handwheel *P*. It serves two purposes: For one thing, it may be used in connection with the quick traverse shaft *L* to adjust the forming roll and cutter to such a distance apart that the latter will center with a roughly cast groove in a barrel cam. By rapidly turning shaft *O* by hand, it can be found whether or not the cutter is centered with the rough cast groove, and if any adjustment is required, this is easily effected by handwheel *P*. Another advantage of this adjustment is that it permits the cutting of cams of very steep pitch. The master-plate made for the contour is cut on a much larger diameter than that desired for the finished work. This larger diameter will give easier rises, permitting the cutter-slide to be moved back against the weight with a smoothness and precision impossible where the pitch is too steep. Graduations are provided for the movement of bracket *J* on the slide, which show how much wider the distance between the cutter-slide and the roll is than the distance between the two spindles as set up in Fig. 3. When the master cam is made to a radius larger by a

Fig. 5. Cams Cut on the Rowbottom Machine

given amount than that desired for the finished cam, the setting of bracket *J* to this dimension on the cutter-slide brings the work to the desired diameter.

The machine, as may be seen, is very rigidly constructed. For large work, slide *E* may be locked to the base after each feeding in to depth, so that heavy cuts can be taken. It will be seen that the machine is universal in its adaptability within the limits of size for which it is designed. In Fig. 5 is shown a variety of examples of its work.

IMPROVEMENTS IN CINCINNATI LATHE

The Cincinnati 16-inch engine lathe, built by the Cincinnati Lathe & Tool Co., Cincinnati, O., was illustrated and described in the September, 1908, issue of MACHINERY. Several improvements have now been introduced on this type of lathe, including a double-walled apron, as illustrated in Figs. 1 and 2, and a new arrangement of carriage and taper attachment, illustrated in Fig. 3.

The apron is of the box type, which gives a double and an especially rigid support to all shafts and studs mounted in it, and provides for accuracy as well as long life of all the working parts in the apron. The gears are of ten diametral pitch, thus having ample strength. The motion to the rack pinion is transmitted by compound gearing, as indicated in Fig. 2. The longitudinal and the cross friction feeds can be started, stopped or reversed while the lathe is running,

but they cannot be engaged when cutting screws; this latter provision is an important safeguard when the machine is in the hands of inexperienced operators. The handwheel is provided with a thread chasing dial which permits the half-nuts to be opened, the carriage to be run back by hand, and the thread to be caught or picked up at any point. An automatic stop is also provided for throwing out the feeds.
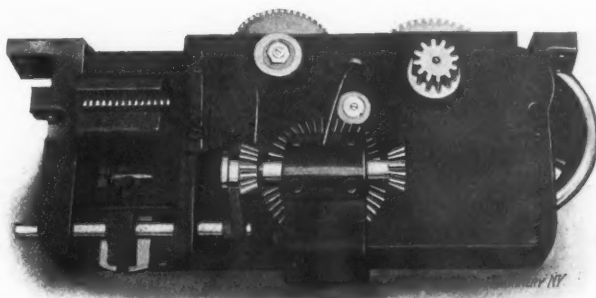

Fig. 1. Rear View of Apron of Cincinnati Lathe & Tool Co.'s 16-inch Engine Lathe
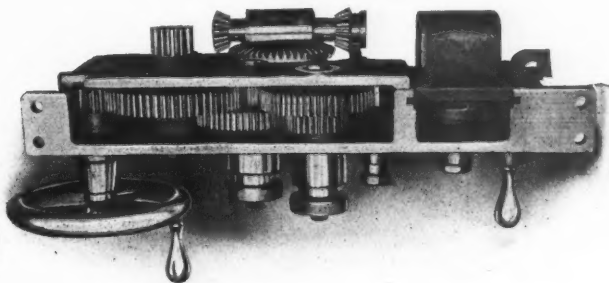

Fig. 2. View from the Top of the Apron of Lathe, showing Arrangement of Gearing

The taper attachment shown in Fig. 3 is provided with graduations at both ends, and can be firmly clamped in any position desired within its range by two heavy clamping bolts, one at each end. The carriage is gibbed both in the front and at the back and bears for its entire length of 22 inches on the V's of the bed. Both plain and compound rests are provided. Due to the heavy construction of the machine in general, as well as to the correct proportioning of the carriage details, very accurate work can be carried out on the machine. As an example, it may be mentioned that it is possible to bore holes on these lathes within 0.00025-inch in 8 inches of feed. As regards the cutting capacity of the lathe, it may
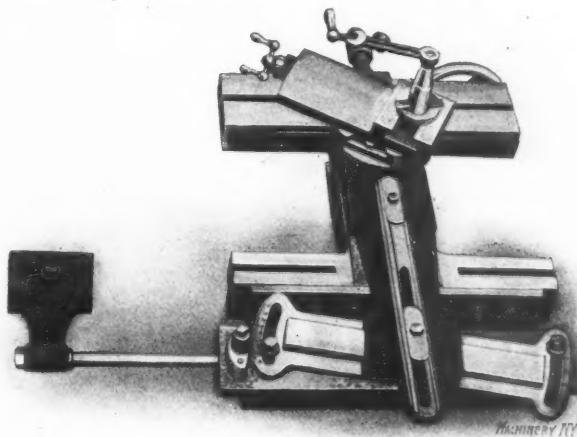

Fig. 3. Carriage Swivel Rest and Taper Attachment

be mentioned that it is used regularly in the shops of the makers for reducing 50-point carbon steel shafts as much as 7/8 inch in diameter with a feed of 1/32 inch per revolution, at a cutting speed of 60 feet per minute.

It will be recalled from the previous description of this machine that it is furnished with a quick change gear-box either for screw-cutting or for feed changes. It may also be furnished either with a 3-step cone pulley and double

back-gears or with a 5-step cone pulley and single back-gears. With a two-speed countershaft this provides for eighteen or twenty changes of speed, covering a carefully selected range.

FIFIELD HEAVY ENGINE LATHE

The accompanying illustrations show an example of a new line of heavy engine lathes made by George W. Fifield, of Lowell, Mass. The lathes of this design range from 40 to

moved toward the right, the pinion on its outer end is thrown into mesh with the internal gear teeth, and the gear at the other end is moved into mesh with the middle pinion on the back-gear quill. When so set, the right hand pinion on the back-gear quill must, of course, be moved out of engagement with the spindle gear.

The connections at the end of the headstock provide for three changes of feed without a change of gearing. On the gear stud beneath the spindle in back of the first of the regular threading change gears, is mounted a cone of three
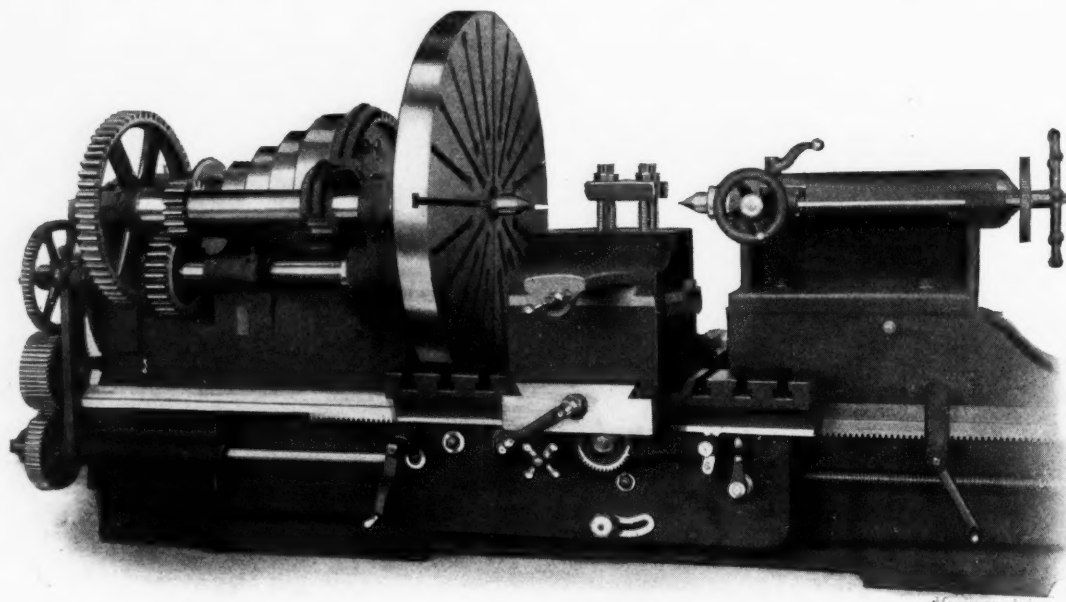
Fig. 1. An Example of a New Line of Heavy Engine Lathes

96 inches swing over the ways. They are of modern construction and are intended for heavy and accurate work and rapid production.

The illustrations show the general features of the design very plainly. The headstock is of the triple geared type with the "back-gearing" mounted on the front to facilitate operation. Power may be applied either directly from the cone
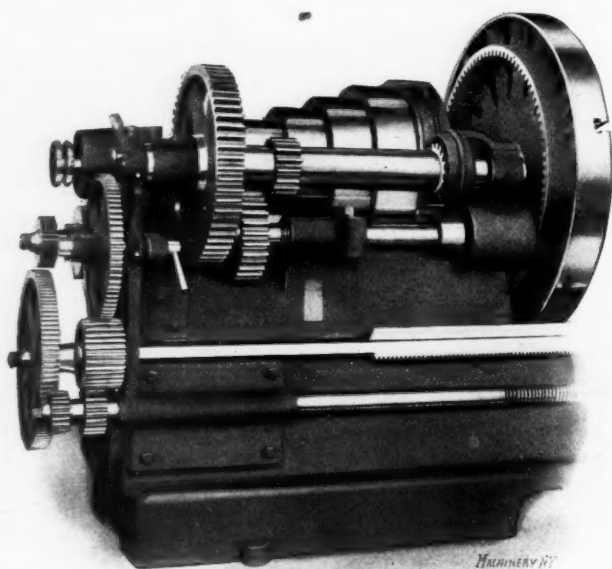

Fig. 2. Driving and Feed Gearing of Fifield Lathe

pulley to the shaft, through back-gears in the usual manner, or through the lower or "triple gear" shaft, which carries a pinion meshing with the internal gear on the back of the faceplate. To connect with this faceplate drive, the lower shaft is thrown to the right by turning with a wrench the square-headed stud shown projecting from the left-hand bearing. This stud has pinion teeth cut in it meshing with grooves in the shaft which act as rack teeth. When the shaft is

gears. On a sector swinging about the splined lead-screw is mounted a large spur gear, adjustable to three positions longitudinally to correspond with the positions of the three members of the cone gears on the stud; a wide-face idler gear between it and the pinion on the lead-screw makes provision for this change of position. The sector is, of course, thrown in or out and clamped into position to agree with the diameter of the gear which is engaged at the time. The connections for thread cutting are made in the usual way.

The feed is reversed in the carriage. The top of the carriage is provided with a series of T-slots to hold special rests, and to clamp work for boring-bar and similar occasional operations. The tool-rest is of the four-stud type, this being most suitable for heavy work. A compound rest is furnished, and the power feed may be applied to both the cross-slide and the compound rest movements.

The 40-inch lathe is driven by a 4½-inch belt on a 5-step cone pulley whose largest diameter is 20 inches. The back-gearing is in the ratio of 1 to 13, while the triple gearing is in the ratio of 1 to 42. The weight is about 12,000 pounds. For the 96-inch swing lathe, the largest of the line, a 6-inch belt is used, running onto a 6-step cone pulley, whose largest diameter is 40 inches. The gearing ratios are, respectively, 1 to 32 and 1 to 250. This tool weighs approximately 70,000 pounds. All lathes are furnished with large faceplates, center-rests, change gears, wrenches and friction countershaft.

BAIRD WIRE-FORMING AND STAMPING MACHINE

The Baird Machine Co., of Oakville, Conn., makes the wire forming and stamping machine herewith illustrated. While this was intended originally for work such as shown in Fig. 2 (suspender loops, buckles and similar parts), the builders have found a wide range of use for it in general work. It is applicable wherever wire parts have to be bent and flattened out or stamped. The machine is essentially a combination of the standard wire-forming machine and a small punch press, the latter part of the mechanism being shown at the left-hand side of the bed.

The machine automatically takes wire from the coil, straightens, feeds and cuts it off, and then forms and stamps it. Work of the character described is made, complete, and dropped into a suitable receptacle at the rate of from 60 to

Fig. 1. An Automatic Machine for Bending and Stamping Work made from Wire

80 per minute according to the size and shape. No further attention is required than that of removing the finished work and keeping a supply of wire on hand.

High-grade materials and workmanship are used in the construction. All the bearing surfaces, such as cam linings, pins, etc., are of hardened tool steel. The sliding surfaces are
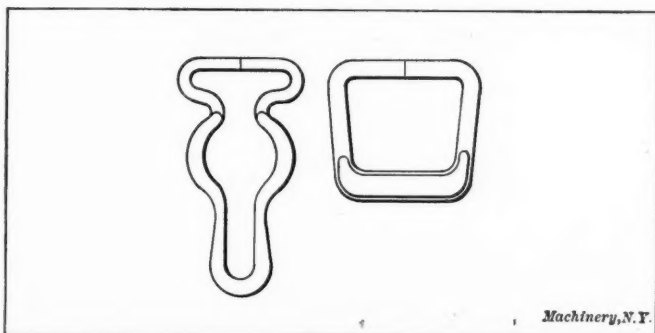
Fig. 2. Examples of Work Done on Machine shown in Fig. 1

hand-scraped to a bearing. The machine is regularly built in two sizes, the smaller of which is designed for articles which do not require more than 6 inches of wire with a maximum diameter of 0.125 inch. The larger size will make use of wire up to 9 inches long and 0.200 inch diameter.

LEIMAN ROTARY BLOWER AND VACUUM PUMP

A new design of rotary blower which is also intended to be used as a vacuum pump, has been brought out by Leiman Brothers, 62 John Street, New York. A diagrammatical view of the design of the device is shown in the line engraving, Fig. 1. In Fig. 2 the blower is shown driven by an electric motor and used as a vacuum pump; it has exhausted the air from a No. 20 gage galvanized iron tank, braced on the inside, which has collapsed on account of the vacuum produced.

As will be seen from Fig. 1, the design of the machine is very simple; the working parts consist only of a central drum or piston, and four wings attached to it by means of hinges. As soon as the machine is in motion, the outer end of these wings will come into contact with the cylinder walls, due in the first place to centrifugal action; but when the machine is in operation, the air that becomes compressed between the wings also tends to keep them in close contact with the cylinder walls, thus preventing leakage. This is one of the principal advantages of the machine, as there is no packing required, and the wings automatically, so to speak, take up their own wear. When each wing reaches the top

where the air is exhausted it is kept close to the inner cylinder wall, so as to insure but a small amount of clearance, as an excessive amount of space here would impair the efficiency of the pump. At the top, the wing still presses against the cylinder wall, the bearing point gradually shifting toward the wing center. Obviously, when considerable wear has taken place on the wings as well as on the cylinder surface, the wings will still conform to the shape of the cylinder, and the efficiency of the device, even when worn, is practically unimpaired. The absence of springs and delicate parts which may break or get out of order, and also of special tips on the ends of the wings which would require frequent renewal, reduces the cost of maintenance to a great extent.

The main shaft bearings are provided with a double ring oiling device. The cylinder is oiled by means of the oil hole at the inlet on the side, but the use of a sight-feed oil cup is recommended. Each blower is supplied with loose and tight pulleys, and can be driven either from
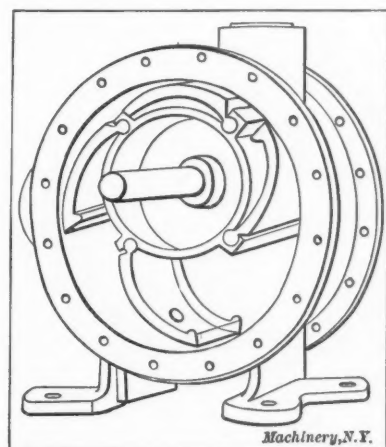

Fig. 1. Diagrammatical View, showing Design of Leiman Blower and Vacuum Pump

an individual motor or from a line-shaft. When the machine is used as a blower, it will produce a maximum pressure of 10 pounds per square inch, but if it is in constant operation it is not advisable to run it at higher speed than to produce a pressure of 6 pounds per square inch. It is made in seven sizes known by the letters A, B, C, D, E, F and G. When used as blowers, the capacity of the various sizes varies from 17 cubic inches of air delivered per revolution for the smallest size, up
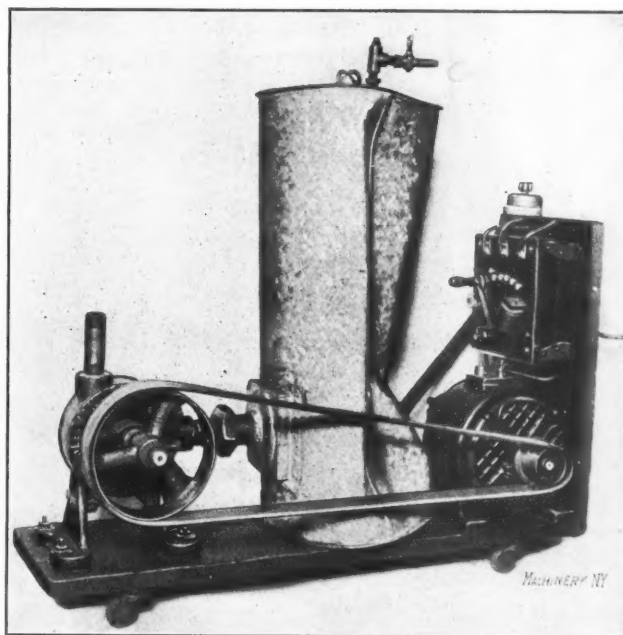

Fig. 2. Leiman Motor-driven Rotary Blower, having exhausted the air of an Internally-braced Tank, causing it to collapse
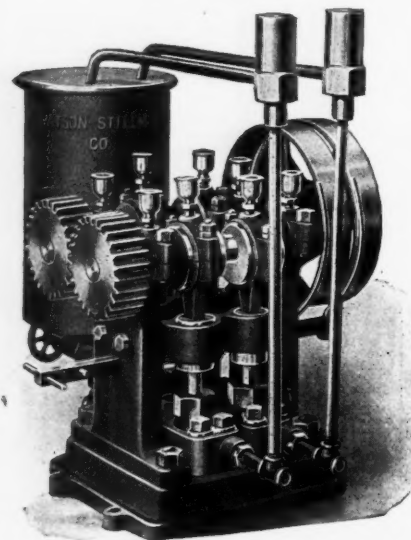
to 1,400 cubic inches for the largest size; the approximate horse-power for the smallest size is 1/10, and that for the largest size 2½. The maximum revolutions per minute vary from 600 on the smallest size to 200 on the largest, and the sizes of inlet and outlet from ½ to 2½ inches.

When used as a vacuum pump, the maximum vacuum is 20 inches, and the displacement per revolution corresponds to the air delivered per revolution by the machine when used as a blower. The approximate horse-power required for the vacuum pumps is the same as that for the blowers. The floor space of the smallest machine is 6 x 10 inches, and that of the largest 24 x 31 inches, the weight of the smallest being

only 20 pounds, while the weight of the largest size is 400 pounds. The vacuum pump is especially intended for all uses where a vacuum of 20 inches is sufficient for the required purpose, as, for example, in vacuum cleaners.

WATSON-STILLMAN SMALL HYDRAULIC PUMP

The accompanying illustration shows a four-cylinder hydraulic pump brought out by the Watson-Stillman Co., 192 Fulton St., New York. In the arrangement shown, two pressure lines are served independently of each other, from a common reservoir; but the type of pump illustrated permits of two, three or four pressure lines being independently served. Each pressure line has a separate pressure chamber, safety valve, and release line, and is served by a separate pair of cylinders with eccentrics set so as to produce a continuous flow. The diameter of the cylinders is ½ inch, by ½ inch stroke. Any pressure up to 600 pounds per square inch may

Four-cylinder, Two-pressure Line Small Hydraulic Pump, made by the Watson-Stillman Co. New York

be delivered into any line, the limit being determined by the setting of the safety valve which opens at excessive pressures and lets the surplus liquid through the release pipe to the reservoir. Any pressure line may be thrown out of service by opening the safety valve, in which case all the liquid will be pumped directly back into the reservoir. The design of the one, two, three and four pressure line pumps is practically the same, except, of course, that the bed-plate and the through shafts are longer. The pump may be provided with an electric motor instead of the fast and loose pulleys for belt drive shown in the illustration.

STEEL SHELVING AND STORAGE EQUIPMENT FOR SHOP USE

The advantages of steel shelving in stock-rooms and store-rooms in machine shops are becoming more and more recognized. One of the most important advantages is the saving
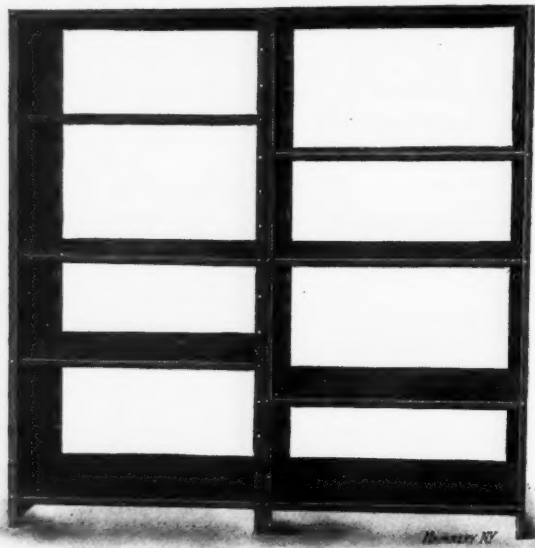

Fig. 1. Two Sections of Terrell's Steel Shelving for Shop Storage

in space, as steel shelving requires to be but a fractional part of the thickness of wooden shelving to have an equivalent strength. It also reduces the fire hazard, is easier to keep

clean, and the cost of maintenance is reduced to a very considerable extent. It is also possible to provide for interchangeability between the different racks and shelving systems in a way that is not possible when wooden shelving is used, and, in addition, it is easier to provide for adjustability as regards the height of the various shelves.
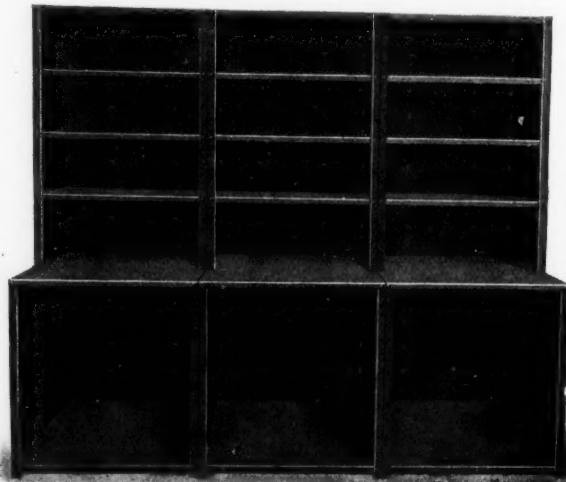

Fig. 2. Rack especially adapted for Die and Tool Storage

The Terrell's Equipment Co., of Grand Rapids, Mich., has placed on the market a stock-room rack, bin rack and racks for die and tool storage, as well as a number of portable tool racks, trays and boxes provided with roller casters and with one or more shelves. In Fig. 1 are illustrated two sections of the regular stock-room rack. The end uprights are made of No. 20 gage steel, riveted to two strips of 1 by 1 by ⅛-inch reinforcing angles. In the front, the uprights are provided with holes for ¼-inch bolts, the vertical distances between the holes being 3¾ inches from center to center. In the back of the uprights, the angles are provided with catches stamped in them and located opposite the holes in the front. By this means rapid adjustment of the shelving is made possible, the space between the various shelves being adjustable to suit the tools stored upon them. This is clearly indicated in Fig. 1. The standard sizes of the uprights for this type of shelving are from 12 to 30 inches wide and from 3 to 15 feet high.
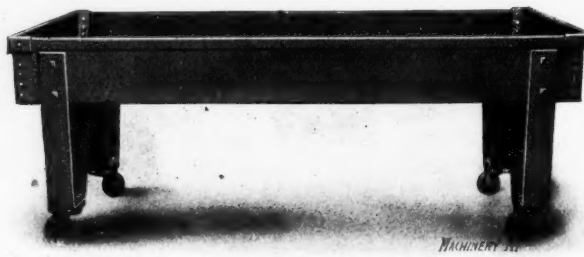

Fig. 3. Box for Material in Process of Manufacture, Tools and Finished Stock

Storage shelving for dies, tools, etc., is usually provided with a back as shown in Fig. 2. The backs are made of No. 18 gage steel and catches are stamped in the backs corresponding with the holes and catches in the uprights. This construction insures a close contact between the shelves and the back so that no material can fall down between. The shelves are made from 24 inches to 40 inches long, the width, of course, corresponding to that of the uprights. They are flanged on the sides and ends, and the front and back edges are double folded to provide for the required strength. In addition to this, the front edge is reinforced with a strip of ¾ by ¾ by ⅛ inch angle which is placed inside the fold.

In Fig. 4 is shown a portable tool rack which is made with or without the drawer shown. The corner posts of this tool rack are made of 1¼ by 1¼ by ⅛ inch angles. The trays are made of No. 16 gage steel, double folded at the top edges, and attached to the corner post with set-screws so that the whole arrangement can be easily taken apart and assembled, and thus be shipped "knocked down." The drawer is made of No. 18

gage steel and is attached to the bottom of the top tray by a steel slide, permitting the drawer to slide easily.

In Fig. 3 is shown a steel box placed on casters, which is made in a large variety of sizes and intended for stock-room, tool-room and shop use for raw material being in process of manufacture as well as for finished stock. The tray or box is made of different gages of steel according to the size. The sides and ends are triple folded and the corners provided with additional reinforcement.

CLEVELAND DRILL CHUCK

The drill chuck shown in the accompanying engraving has been placed on the market by the Cleveland Collet & Machine Co., Cleveland, Ohio. It is designed for holding a drill to the limit of its torsional strength, yet it is easily released by hand. No wrench is necessary as the resistance of the cut is utilized for increasing the grip on the drill, while, when the pressure is relieved, the jaws open easily by turning the chuck body by hand. The chuck consists of a shank
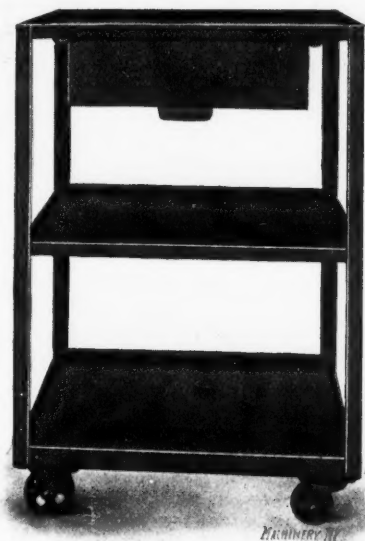
Fig. 4. Portable Tool and Storage Rack for the Shop
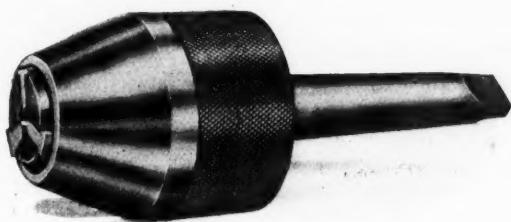
Drill Chuck made by the Cleveland Collet and Machine Co.

part threaded into the knurled chuck body, to the end of which latter a tapered sleeve ring is attached. Three jaws slide with their back faces against the inside of the sleeve ring. The jaw holder rotates independently of the body only when a drill is not locked between the jaws; but when the drill is in place, it is locked in the jaw holder and the jaw holder in the sleeve by screwing up the chuck body on the shank, thereby producing the required pressure on the back of the jaws by means of the tapered surface in the sleeve ring. A ball thrust bearing is provided for taking the axial thrust, and in this manner the thrust on the thread on the shank is minimized. Another valuable feature of this ball bearing is that it prevents the drill and jaws from becoming so tightly gripped that it would not be possible to release the grip by the hand alone. The construction of the tool is simple, and as there are but few working parts, it is not likely to get out of order. This is an important consideration, as the time lost in repairs is often considerable when tools are unnecessarily complicated.

BLISS POWER PRESS FOR HEAVY COLD STAMPING

The straight-sided single-action press shown herewith was recently built by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., for the Hydraulic Pressed Steel Co., of Cleveland, O. As indicated by the firm name of the customer, this tool was designed to replace the hydraulic machine on work of a character which has not hitherto been done by a crank machine. Its advantage, of course, lies in doing the work much more rapidly than is possible with hydraulic motive power, and more accurately as well, since the dies are bedded in long slides, gibbed with great care.

This press is of the makers built-up type, in which four vertical tie-rods of large diameter are depended on to receive the tensile stress imposed while the press is in operation, thus relieving the frame columns of all stress of this character. The columns are of heavy cross-section, giving great rigidity to the machine. Heavy extended feet are provided, so that ample stability is insured.
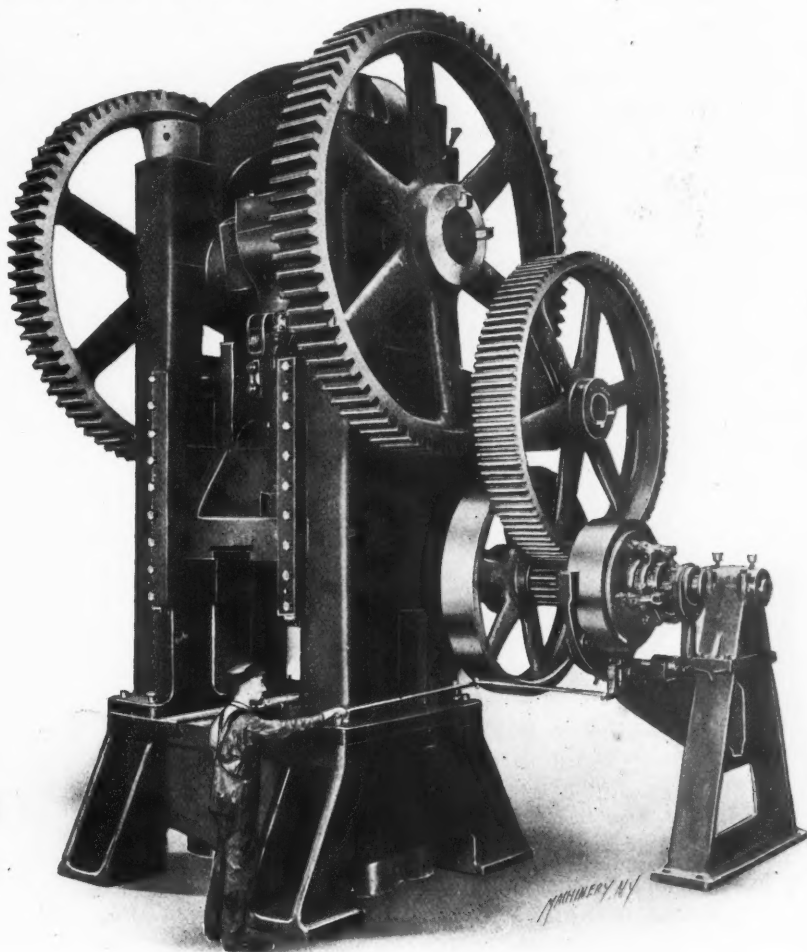

Fig. 1. A Crank Press designed for Work formerly done on the Hydraulic Press

Some idea of the massiveness of the construction may be obtained from Fig. 3, which shows the slide, weighing over seven tons. Fig. 2 shows the crankshaft with its two main gears, one at each end. These weigh over 6 tons apiece. The double drive reduces the bending and torsional strain on the crankshaft. The driving gearing throughout is of steel, compactly arranged, and with machine cut teeth. The machine is controlled by a hand-lever, operating a combined friction clutch and brake. The clutch is of improved type with heavy rigid friction surfaces, arranged to be relieved of rubbing contact when not driving. A safety coupling attached to the fly-wheel permits it to free itself in case the press is subjected, through accident or carelessness, to a pressure greatly in excess to that for which it is intended.

The bed of this machine has an area of 60 by 48 inches. The crankshaft is 16 inches in diameter. The total weight is 164,000 pounds. It is believed to be the largest machine of its type ever built. Large double crank presses and drawing presses are not unusual, but this tool is designed to enter a

new field for the power press, in the cold forming of sheet metal of extra heavy gages. It is particularly adapted to such work as stamping sheet steel brake drums, axle housings, etc., for automobiles. On such work it gives more accurate results and a much higher production than the hydraulic press can attain.

BEAMAN & SMITH NO. 10 BORING AND MILLING MACHINE

The tool herewith illustrated and described is made by the Beaman & Smith Co., of Providence, R. I. It is of the type which has come into such extensive and well-deserved popularity in the past decade, in which the work is mounted on a table provided with longitudinal and cross movements, while the spindle is mounted in a saddle which may be adjusted
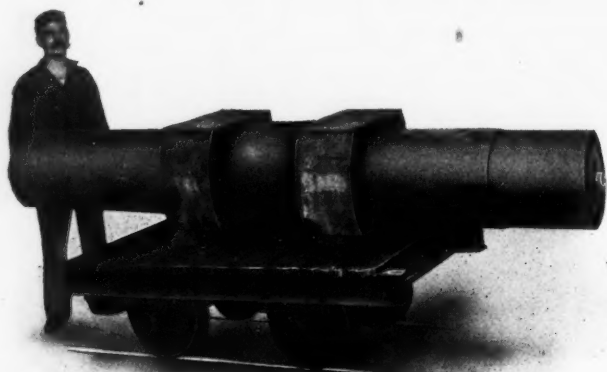
Fig. 2. A Crankshaft 15 inches in Diameter

or fed vertically on the face of an upright column. This arrangement supports the work and the boring-bar under the most favorable conditions for a wide range of operations.

A distinctive point in the design will be seen at once from an inspection of the engraving. This relates to the form of all the main castings of the machine. A tubular section has been used throughout, this being applied to the bed, the column, the outboard bearing and the feed bracket for the boring-bar. It is not necessary to expatiate on the stiffness of this form of section in resisting torsional strains or bending strains. It would seem to be especially suited for machine members of this kind, and its use gives the whole machine a distinctive and pleasing appearance, which is even more evident in the machine itself than in the photograph which we have reproduced.

The feed and speed changes are obtained by gearing from a constant speed pulley. There are 18 changes of speed, obtained through the gear-box shown at the extreme right of the engraving, in conjunction with the back-gear handle shown projecting through an opening in the gear guard at the top of the saddle. The changes range from 4.34 to 125 revolutions per minute, giving suitable speeds for the drilling of small holes and for large facing or heavy milling operations as well. Ample power is provided by the 5-inch belt drive on the 14-inch pulley, running at 230 revolutions per minute. The gearing ratios vary from 1 to 1.8 for the fastest speed, up to 1 to 52.5 turns of the pulley to one of the spindle for the slowest speed given above. The spindle has a No. 5 Morse taper hole with a driving slot across the end.

The boring-bar has a continuous traverse of 30 inches and a maximum traverse of 60 inches by shifting its position. Eight feeds are provided, operated by the quick change gear mechanism shown at the foot of the column. These range from 0.009 to 0.252 inch per revolution of the spindle for drilling and boring. For milling, the speeds range from 0.56

Fig. 3. A Massive Slide, weighing over Seven Tons

to 15.7 inches per minute at any spindle speed. It will be seen from this that the feed is connected with the constant speed driving shaft when milling, and with the spindle when drilling and boring, so that the arrangement of the feeds is exactly suited to each of these two operations. This construction is, so far as we know, a new one in machine tool design, machines having hitherto been constructed so that one of the two connections was made, but not so that both of them were available. For milling, the feeds are applicable to the cross-
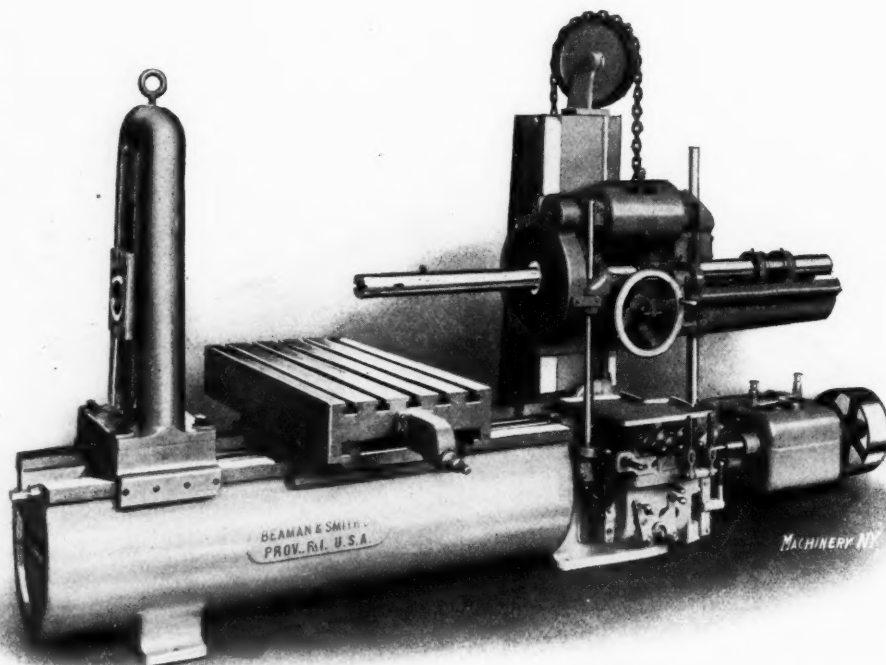

Fig. 1. Beaman & Smith Horizontal Boring and Milling Machine

feed of the table as well as to the vertical feed of the saddle on the column. Power rapid traverse is also provided for these movements.
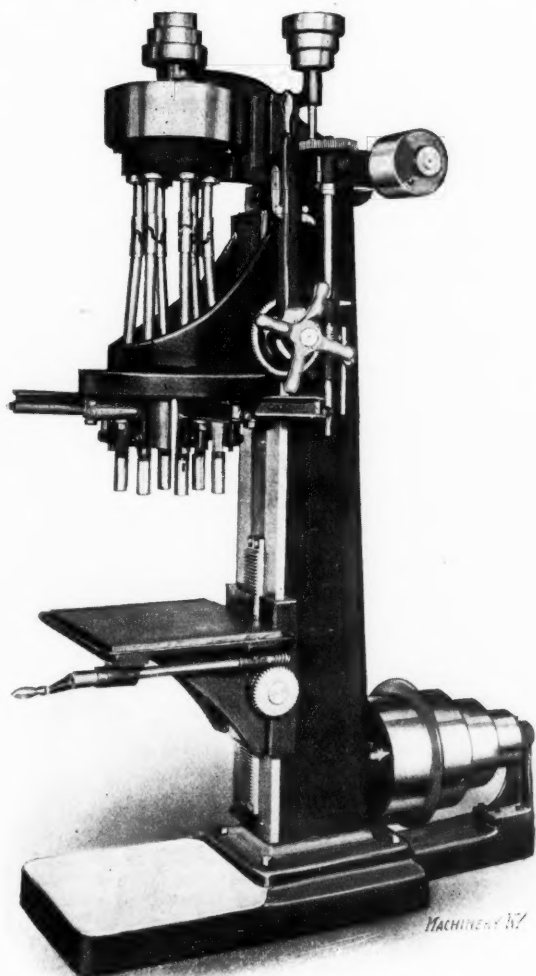
The outer support has a bushing hole 4½ inches in diameter, and is connected in unison with the head saddle so that the two are always in line, whether the adjustments are made by hand or power. The bushing block is carried between uprights, instead of on the side, so that the maximum of rigidity

is provided. Longitudinal adjustment on the bed is effected by a screw.

The general construction of the machine is of the highest grade. The sliding surfaces are accurately scraped. The adjusting screws are of generous dimensions. All gearing is cut from the solid, the bevel gears being generated by the Bilgram process. Bearings are bronze lined, wherever necessary. Spindles and shafts are accurately ground to size. As to the capacity of the machine, the least distance from the center of the spindle to the top of the table is 3 inches, and the greatest 25 inches; the vertical adjustment is 22 inches. From the spindle driving gear, which is 18 inches in diameter, to the outer support, the shortest distance is 27 inches and the greatest 5 feet 6 inches. The 24- by 48-inch table has a cross feed of 36 inches and a longitudinal movement on the bed of 40 inches. The weight of the machine is approximately 11,000 pounds.

FOX MULTIPLE SPINDLE DRILL

The tool herewith illustrated is one of a line of multiple spindle drilling machines built

Fig. 2. Rear View showing Tubular Section used throughout in the Construction of Machine Members

Multiple Spindle Drill of the Adjustable Lay-out Type

by the **Fox Machine Co.,** 815-825 N. Front St., Grand Rapids, Mich. These machines are designed especially for using high-

speed drills, and will be found useful for automobile and gas engine work, and for general manufacturing.

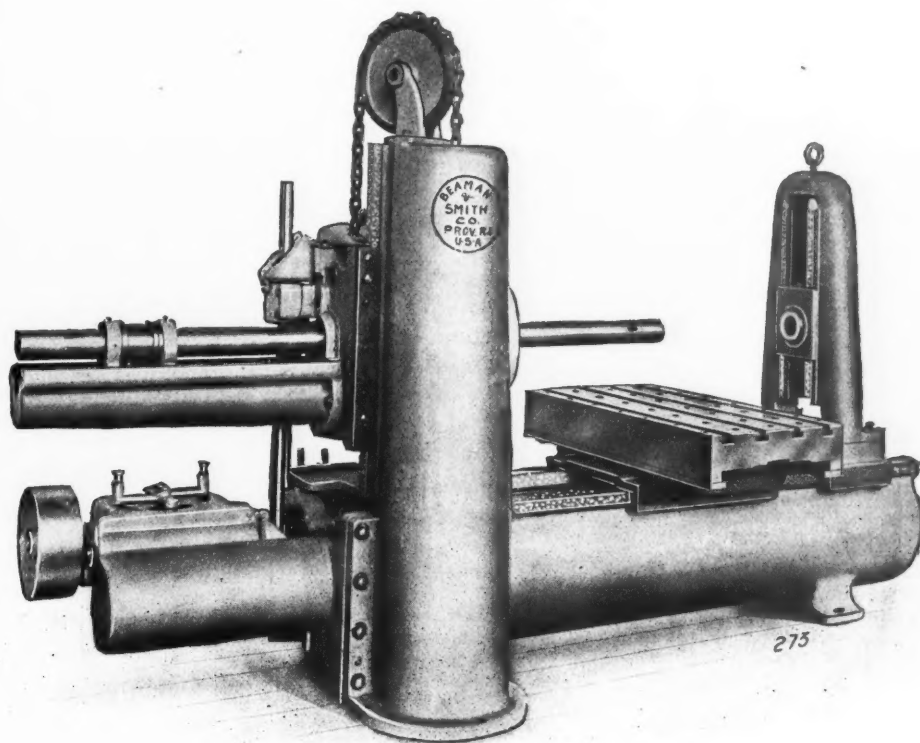The particular machine illustrated is the No. 1 size, provided with a round head. This is fed downward along the face of the column, inside of which is a weight for counterbalancing the movement. The power feed movement of 5 inches is transmitted through the swinging vertical shaft, which carries a worm engaging a worm-wheel on a rack pinion shaft. An automatic knock-off disengages the gearing at the end of the drilling operation. The hand lever shown provides for manual operation in the case of light work.

An exclusive feature of this machine is the design of the spindle bearings, mounted on the adjustable supporting arms. The construction gives a long stiff bearing, and one which is at the same time adjustable in a vertical direction without disturbing the setting of the other spindles. Patents are pending on this construction.

The base of this machine is 4 feet 6 inches by 18 inches. The table is 16 by 16 inches, having a vertical adjustment by a worm and worm-gear as shown in the engraving. Three spindle speeds are provided—262, 525 and 1050 revolutions per minute, respectively. The automatic feed has three changes, giving 0.0038, 0.0059, 0.0098 inch per revolution of the spindles, respectively. The driving connections by which these changes of feed and speed are obtained are exceedingly simple, and will be readily understood from the engraving.

* * *

During the month of August, 194 automobiles valued at $333,960 and parts valued at $114,973 were imported into the United States. Of the 194 cars imported, 109 came from France, 52 from Italy, 9 from Germany, 8 from the United Kingdom, and 16 from other countries. During the same month 360 automobiles were exported, valued at $567,964. During the first eight months of the year 2,140 cars, valued at $5,107,953 were exported. An interesting thing to note is the high average price of the exported cars, which is about $2,500, indicating that the United States is rapidly taking a place among the nations exporting high grade automobiles.

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The ordinary incandescent lamp with carbon filament requires about 3 watts per candle-power; the incandescent lamp with tungsten filament, 1.25 watt; the arc lamp, 1 watt; and the Cooper-Hewitt mercury vapor lamp ½ watt.

NEW MACHINERY AND TOOLS NOTES

No. 7 Disk Grinder: Gardner Machine Co., Beloit, Wis. This is a disk grinder of the same design as followed by the maker in the older members of his line, but intended for larger disks up to 30 inches in diameter. Greater belt power is also provided.

Furnace for Lead and Cyanide Baths: United States Gas Furnace Co., Providence, R. I. This furnace is intended particularly for heating baths of various substances for hardening steel parts. When used for lead, an open fire is permitted, but for cyanide a hood is fitted to carry the fumes away.

Die Sharpening Machine: National Machinery Co., Tiffin, O. This little tool is designed for threading dies or chasers for bolt and pipe work. It grinds these dies to uniform depth, giving them a proper cutting angle and clearance, so that each chaser will have the same amount of work to do. A 6-inch wheel is used, mounted on a spindle running in bronze bearings. Suitable graduations are provided for setting the machine.

Small Motor-Driven Shaper: L. E. Rhodes, Hartford, Conn. The Rhodes small shaper is now provided by its makers with a substantial iron base and a motor-drive, whenever required by the customer. A Lincoln motor is used, giving a 6 to 1 speed range; it is connected to the driving shaft by chain and sprockets. This combination should be useful in manual training schools, for model makers and others whose work is similar.

Oxy-acetylene Welding Apparatus: Oxy-Carbi Co., New Haven, Conn. This firm makes apparatus for the continuous generation of oxy-acetylene under suitable control, so as to be generated and mixed at the time it is used. The apparatus is made in either portable or stationary form. Suitable welding and cutting torches are furnished for the wide variety of work for which this process has been found adapted in the past two or three years.

Alligator and Combination Wrenches: W. S. Ducharme, Johnstown, Pa. The combination wrench made by this firm may be used as a pair of pliers or as a screw-driver, in addition to its use as a wrench. As a wrench it is self-adjustable, the jaws automatically closing as the pull increases. The alligator wrench is also adjustable, by means of a thumbscrew, adapting it to a wide range of sizes. A reversible jaw allows the wrench to be used in either direction.

Precision Spirit Level: Izard-Warren Co., 136 No. 12th St., Philadelphia, Pa. This style of precision level is built in six sizes, ranging from 2 to 24 inches in length. The bulbs are carefully made and are so ground as to indicate a variation of one-thousandth inch in the length of the level. A cross bulb is provided to make sure of the proper setting of the instrument. The body is of cast iron and the top of brass. The tool goes under the name of "Sterling Machinists' Precision Level."

Motor-Driven Precision Lathe Outfit: Rivett Lathe Mfg. Co., Brighton, Boston, Mass. This is a Rivett precision lathe mounted on a special cabinet with countershafts, etc., and a motor-drive enclosed in the base. The cabinet is of quartered oak, nicely finished, with a top surface which takes the place of the work bench on which the lathe is usually mounted. The whole arrangement provides places for the storing of attachments, tools, etc., in a way that is very convenient for a user of a precision tool.

Cold Heading Machine: Waterbury Farrell Foundry & Machine Co., Waterbury, Conn. This firm has lately produced what is supposed to be the largest cold heading machine made, being adapted to automatically produce work up to ⅞ inch in diameter and 4 inches long. The weight of the machine is over 42,000 pounds. It embodies the principles of the smaller machines of the same line, but changes have been made in details to cover the greater massiveness and rigidity required for heavy operations.

Improved Bevel Protractor: L. S. Starrett Co., Athol, Mass. This protractor is intended to be a member of the makers' well-known combination square sets, being used in connection with a graduated rule or straightedge. The improvement in the construction consists in the fact that its head extends on both sides of the blade, permitting angles to be transferred from either side of the frame without resetting. The readings indicate the supplement of the angle as well as the angle itself, thus facilitating the use of the tool.

Punch Press: Atlas Machine Co., Waterbury, Conn. This is a power-driven machine designed for light punching and stamping operations, and intended to take the place of the orthodox foot press, producing a more even pressure and more uniform work, and obviating the fatigue of the operator. The machine is controlled by a one-revolution clutch, connected to a treadle. The distance from the top of the bed to the lower end of the ways is 6 inches. The bed surface is 7½ by 12 inches. The total weight of the press complete is 500 pounds.

Scroll Chucks with Adjustable Jaws: D. E. Whiton Machine Co., New London, Conn. These tools are really a combination of independent and scroll chucks, inasmuch as they permit an individual adjustment for each jaw, this being provided by a screw mounted in the base of each which adjusts the scroll nut with relation to the jaw. This arrangement permits keeping the chuck true, without repeated grinding or boring of the jaw faces. These tools are also made with four jaws, so located that they may be used either as two-jaw or three-jaw chucks.

Adjustable Planer Gage: Tip Top Tool Co., 78 Vernon St., Worcester, Mass. This planer gage is of the type in which an anvil is adjusted up or down the inclined surface of a wedge, so as to form a measuring block having parallel surfaces which may be set for any distance apart from 3/16 inch to 1½ inch. This wide range is permitted by the fact that the measuring block has two steps of different heights. No graduations are furnished, it being designed to set the block by the aid of micrometer calipers. A fine adjustment is provided similar to that used in vernier calipers.

Nine-Spindle Milling Machine: Beaman & Smith Co., Providence, R. I. This firm has recently equipped its planer type of milling machines with a set of special heads carrying nine spindles. The side heads are provided with three spindles each, and the crossrail head has two on the front and one in the rear. This arrangement permits the machining simultaneously of the sides of the flange of automobile cylinders, the faces of the upper and lower valve openings, the spark plug boss and the inlet and exhaust connection bosses. The time required for finishing them is thus materially reduced.

Hack-Saw: Massachusetts Saw Works, Chicopee, Mass. This saw has a number of improvements in construction, of which the most notable one is a provision for adjusting the stroke automatically with the size of the work, so as to use, at all times, the full length of the saw blade. This adjustment is connected with the sliding vise jaw, so that no attention is required to it on the part of the operator. The blade is automatically relieved on the return stroke, which is made with an increased speed, due to the use of a quick-return mechanism. An automatic knock-off is provided to stop the machine when the cut is finished.

Universal Collet: Cleveland Collet & Machine Co., Cleveland, O. This is a chuck or collet of the draw-in type, intended for application to the engine lathe. Its principal advantage lies in the fact that it is adjustable for a wide range of work, it not being necessary to provide a large number of separate spring collets to cover the range, as is usual. The work is held by jaws which are opened or closed for a change in diameters, in a manner somewhat similar to the ordinary scroll chuck. The tightening of these jaws on the work, however, is effected as usual by a handwheel at the rear end of the spindle, acting on a tube passing through the latter.

Coil Clutch: Farrel Foundry & Machine Co., Ansonia, Conn. This clutch is of the type in which frictional contact is produced by the tightening of a heavy steel spring, which forms one member, about a drum or barrel, which forms the second member. As is well-known, this construction gives a very heavy gripping power for a slight pressure in the tightening of the spring. This particular design has been built for powers as high as 8,000 at 60 revolutions per minute in one English installation. The spring is hand-forged from a high-grade of steel and the drum is of chilled iron, making a very durable and substantial construction. The line covers a wide range of sizes.

Variable Speed Sensitive Drill Press: Villinger Mfg. Co., Williamsport, Pa. This drill press is a simple machine with a number of new features, among them being a connection of the feeding handle with a friction disk drive in such a way that this handle serves to vary the rate of speed as well as to feed the drill. Pushing the handle to right or, left changes the speed, while drawing it down feeds the drill as usual. In addition, connections are provided which stop the spindle when the feed lever is turned back to its upright position. A key is provided which holds the table central with the drill at whatever vertical height it is adjusted. This key can be withdrawn, however, to permit swinging the table from one side to the other as may be required for special cases.

Crank Planing Machine: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. This is a tool which has found much favor in railroad and locomotive shops and other places where cuts are to be taken on comparatively small pieces of tough metal. The framework of the machine is of the planer type, but the table is actuated by a crank motion of variable stroke driven by a Whitworth quick return movement, similar to that used in many designs of shapers. The saddle is provided with power cross-feed on the rail, and the tool slide has a vertical or angular down feed on its slide. The machine is very strongly and ruggedly built, and is capable of taking heavy cuts, owing to the fact that all cutting strains are rigidly resisted by the disposition of the metal in the framework.

Cam Grinding Attachment for Standard Grinding Machines: Norton Grinding Co., Worcester, Mass. This attachment may be applied to the maker's standard type of grinding

machine. The desired outlines on the surfaces to be ground are produced by master cams or templets, which swing the work in toward the wheel or away from it as may be required to give the desired contour. A series of templets is provided, one for each of the different cams on the shaft, so that each is of the proper shape and properly located to give the correct timing. The whole arrangement is very simple, and easily applied and operated. It should result also in the production of cam surfaces of a high grade of accuracy. Provision is made in the device for grinding the templets or master cams from models, which are thus exactly reproduced in the contour of the work.

BLUEPRINT STORAGE TUBE: G. Chalmers Brown, New London, Conn. This tube is intended for the storage and use of blueprint paper from the roll. It may be fastened to a bench or side of the wall. The roll of paper is inserted in the end of an inner tube, after which this inner tube is turned around so that the opening in its side is out of line with the opening in the outer tube. The paper is thus safely sealed against the entrance of light. In removing the paper, the inner tube is turned around until the openings register and the paper is pulled out through the slot thus provided. A tape-measure is mounted on the apparatus which is pulled out at the same time with the paper, accurately measuring the length of the sheet removed. The paper is torn by drawing it cornerwise across the sharp edge of the opening. This tube should find favor on the score of economy and convenience in the use of blueprint paper.

36-INCH RADIAL DRILL: Dreses Machine Tool Co., Cincinnati, O. This machine resembles the previous designs of the same builders in the construction of the spindle head, feed, etc. It is provided, however, with a new driving connection between the horizontal shaft on the arm and the vertical shaft inside the column, which does away with a considerable amount of mechanism, including two spur gears, a shaft and two bearings. The elevating screw is placed in a recess in the front of the column where it does not lessen the swing of the machine. An improved clamping device is provided which binds the column, the table and the stump together by a single movement of the lever. The table may be adjusted to keep it always perpendicular to the spindle. The machine will be furnished either with cone pulley or gearbox drive, or with constant or variable speed motor drive. It drills to the center of 73-inch circles, takes 78 inches between the center and the base and weighs about 3,600 pounds.

LESTER AUTOMATIC SCREW MACHINE: Davis Sewing Machine Co., Dayton, O. This is a multiple spindle machine involving a number of novel features in its construction. For one thing, it has three stock spindles in place of the usual four or five. The indexing and cam movements are so arranged that these three spindles, on simple work, can be made to form three pieces at each revolution of the cams, without indexing; these pieces may be alike or different as may be required. On plain work, it may thus be seen, the machine has a very high capacity. Another new point in the design is the large number of tools provided. There are six stations in the tool-holder and three cross-slide tools, this making nine cutting operations possible for each piece; and as many of these operations may be arranged to make use of multiple cuts, the range of work to which the machine is adapted is very large. The size of machine at present built has a capacity for stock up to 1 inch diameter, and a length of feed for turning up to 4 inches.

MACHINE FOR TESTING RUNNING BALANCE: The Norton Grinding Co., Worcester, Mass. The obtaining of standing balance in a rotating part is a comparatively simple operation, it being common to roll the work along knife edges or between centers, and mark the heavy side as indicated by the position in which the part comes to rest. The obtaining of a running balance, however, is another matter. It has always been done by homemade contrivances, more or less clumsy and slow. The Norton Grinding Co. has recently devised a piece of apparatus for this work which greatly simplifies the operation and permits it to be done much more quickly and accurately than ever before. Briefly, the part to be tested is provided with two supports, one on each end, on which it is rotated rapidly by an electric motor. These supports are floating, and indicate every vibration by means of a lever magnifying arrangement. Provision is made for marking the high side at each support to show the running out permitted by the floating bearing. By reversing the rate of ratio the lag due to the inertia of the floating and indicating parts is compensated for. For long and slender work provision is made for supporting and indicating at one or more intermediate points as well as at the ends. The whole apparatus is well-designed and conveniently arranged, and should prove especially useful in automobile work, high-speed drums and pulleys, and in woodworking machinery building in general.

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The Pennsylvania R. R. tunnels from Bergen Hill, N. J., to Long Island City were practically completed December 3 when the final section of concrete was placed in line D, the fourth and last of the tunnels under the East River, to the Sunnyside Yard, Long Island City.

GEORGE WESTINGHOUSE

ARTHUR WARREN

The new president of the American Society of Mechanical Engineers needs no introduction to engineers of any branch, nor to the general public the world over. He has been famous and honored everywhere these forty years, for it was in 1868, and at the age of twenty-two, that he brought forward his great invention, the air brake, which it has been said "ranks next to the press and the locomotive among those forces to which the material developments of the present age primarily are due." The evolution of the air brake under his personal inventiveness in the years that have passed since he first originated the device has made the modern railroad possible. Without the control which the air brake gives, high speed, frequent service, long trains, huge cars, heavy loads, would be unknown. The air brake, therefore, is not only a safety device; it is also a most important operating device on a railroad.

George Westinghouse was born October 6, 1846, at Central Bridge, Schoharie County, in the state of New York, a son of George and Emeline Vedder Westinghouse. His father was a manufacturer of agricultural machinery at Schenectady. Out of school hours the boy taught himself engineering, and it was his idea of a holiday and a vacation to work in his father's machine shop. Before he was seventeen he enlisted for the Civil War, serving first in an infantry regiment and next with the cavalry. Then, passing an examination for the purpose, he was transferred to the Navy where he served during the remainder of the war as an Assistant Engineer. In the same year that he returned to civil life, 1865, he entered Union College and invented a device for placing derailed cars on the track. Three years later he thought out and patented the air brake. He had to guarantee the railroad which made the first trial with the brake that he would pay for any damage that might be done to the train as a result of equipping it with the apparatus and running a trial trip. Instead of damaging the train, his brake prevented a fatal accident on the trial run and then the skeptical railroad officials expressed astonishment and enthusiasm, and men who had thought it "impossible to stop a train with air" were eager to buy the invention.

Young Westinghouse, however, declined to sell. He formed a company, took a workshop in Garrison Alley, Pittsburg, and began to manufacture the remarkable contrivance which he had invented. In a year the new works had thirty-six employes, including clerks and office boy. From that modest beginning have grown the great works of the Westinghouse Air Brake Co. at Wilmerding, Pa., and the town of Wilmerding itself. From the fruits of the inventor's genius, energy and capacity as an organizer of industry have developed thirty companies, of which he is president, employing 50,000 men, $120,000,000 of capital, and manufactories at East Pittsburg, Swissvale, Trafford City, and Wilmerding, in Pennsylvania, in London and Manchester, England, and in

France, Germany, Italy, Austria and Russia. There is not a civilized country in which the name Westinghouse is not familiar. Air brakes, electric motors and generators, steam and gas engines, steam turbines, railroad switches and signals, and a multitude of other things testify to the inventive and industrial energy of this distinguished man.

After inventing the brake he took up the study of railroad signals and switches and showed how these could be operated with compressed air. Having done this, he combined electricity with the pneumatic operation of these devices. Thus he was led further and further into the pursuit of the then new electrical art. Convinced of the practicability of conveying electrical currents over great distances, he resolved to develop the alternating system for that purpose. From Europe he acquired the patents of Gaulard and Gibbs. He brought Tesla to Pittsburg, backed him financially, placed laboratory and workshop facilities at his disposal, and the result was the invention of the induction motor for utilizing the alternating current for power purposes.

The great successes of Mr. Westinghouse have not been gained without opposition. His strength of character, mind and resource, however, has always been brought forth in encounters, and he has always won. Opposition to the alternating current system developed to an extraordinary extent. Men who should have known better, and do now, declared that the alternating current was impracticable, and that if ever made practicable its use would be deadly and a menace to the public welfare. Legislation was invoked against it in many states. These efforts were really meant to be, whatever the legislators may have thought, a systematic attempt to check George Westinghouse in his plans for bringing electricity within the reach of all. And to prove to the populace the "danger" of the system which he advocated, some of the opponents prevailed upon the authorities to use an electrical death-chair for the execution of convicted murderers! The originators of this brilliant idea, and of the campaign against the alternating current system, found themselves as impotent as King Canute when he commanded the incoming sea to retreat. Scientifically, commercially, and in every way, the alternating system proved to be what the world required for the general adoption of electric currents on a large scale, and the opposition was defeated. Similarly, in the hard times of the early nineties, men who desired to monopolize the manufacture of electrical machinery took advantage of the generally depressed conditions of affairs throughout the country, and endeavored to drive Mr. Westinghouse into a corner, and to obtain control of the electrical manufacturing company which he had founded, organized and built up into a great center of industry; but the attempt to overcome him was unsuccessful. The panic of 1907 caused a renewal of this kind of attack, but as Andrew Carnegie is reported to have said, "George Westinghouse is a genius. You cannot keep him down!" What is more, you cannot get him down. He is one of the world's strong men.

At the time of the Chicago exhibition the electrical illuminations of that vast and beautiful undertaking were the most remarkable that had ever been seen. George Westinghouse offered to take the electrical contract for a million dollars less than the figure which the exposition authorities were on the point of agreeing to pay the bidders who seemed to be the most successful. "It cannot be done," the competing bidders said to the exposition authorities. "But I will do it," said Westinghouse. And then they undertook to show that they monopolized the lamp patents of that time. This they thought would make him powerless in the matter, but he persuaded the authorities to postpone the decision, and they, glad enough to save a million dollars, and having faith in the man, consented to the postponement. Mr. Westinghouse returned to Pittsburg, invented a lamp, returned to Chicago, secured the contract and saved the exposition a million.

George Westinghouse has invented many things, and has encouraged invention in the engineers associated with him. He devised a system for mechanically controlling the flow of natural gas, and piping it over long distances for use as fuel in the industries and homes of Pittsburg. He built the first ten great generators for Niagara, and those for the ele-

vated and subway lines in New York, and for the Metropolitan Railway in London. It is impossible within the present space to enumerate either his inventions or his business achievements. His work has frequently taken him into many countries, and distinguished men of all callings and sciences are, and long have been, among his personal friends. Of these, Lord Kelvin was the first recipient of the John Fritz medal. George Westinghouse, by the way, was the second person to receive the John Fritz medal. The French Republic, the late King Leopold of Belgium, and the late King Humbert of Italy decorated Mr. Westinghouse. The Königliche Technische Hochschule of Berlin gave him the degree of Doctor of Engineering. He was, in 1905, selected as one of the three trustees to hold the voting power of the stock control of the Equitable Assurance Society, being associated in this important trust with ex-President Grover Cleveland, and Justice Morgan J. O'Brien. He is president of the American Society of Mechanical Engineers, is one of the two honorary members of the American Association for the Advancement of Science, and an honorary member of the National Electric Light Association.

The latest activity of Mr. Westinghouse is the bringing before the attention of the marine engineers of America and Europe the reduction gearing and "floating frame" invented by Rear-Admiral Melville, ex-Engineer-in-Chief, U. S. N., and John H. Macalpine. The purpose of this invention is to enable high-speed steam turbines to drive the propellers of steam vessels, thus obtaining from the propellers and the turbines their highest efficiency. Mr. Westinghouse supplied the means for constructing and testing this important invention, and at the same time developed a marine turbine of his own which is said to be a great improvement over any now in use. This turbine has been used in the tests of the Melville-Macalpine gear, tests which are reported to be of a remarkably satisfactory character.

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ANNUAL MEETING OF THE A. S. M. E.

The thirtieth annual meeting of the American Society of Mechanical Engineers was held in New York, December 7 to 10 inclusive, the Engineering Societies Building, 29 West 39th St., being the headquarters. The registration of members was 638, and including guests, 1063. The program was substantially as follows:
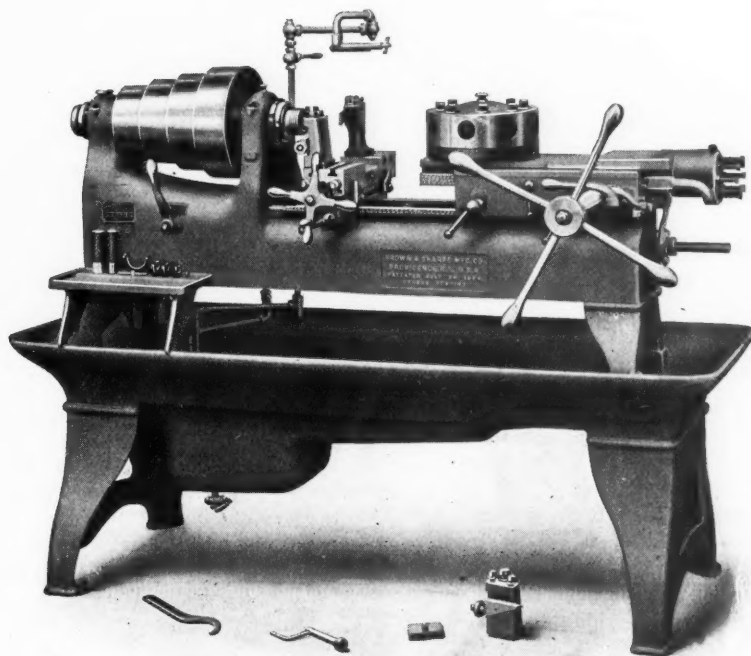
Tuesday.—President Smith's address, "The Profession of Engineering," and the introduction of President-elect George Westinghouse, followed by a reception held by the president, president-elect, Secretary Rice and Honorary Secretary Hutton with their ladies.

Wednesday.—Annual business meeting, reports of membership, standing and special committees and gas power section. In the afternoon a large party went through the new Pennsylvania R. R. terminal and passenger station at 7th Ave. and 31st and 33d Sts. In the evening an interesting stereopticon lecture was delivered by L. W. Ellis of the Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C., entitled "The Era of Farm Machinery."

Thursday.—"Tests on a Venturi Meter for Boiler Feed" by Charles M. Allen; "Pitot Tube as a Steam Meter" by George F. Gebhardt; "Efficiency Tests of Steam Nozzles" by F. H. Sibley and T. S. Kemble; "Electric Gas Meter" by C. C. Thomas; "Tan Bark as a Boiler Fuel" by David M. Myers; "Cooling Towers for Steam and Gas Power Plants" by J. R. Bibbins; "Governing Rolling Mill Engines" by W. P. Caine; "Experience with Leaky Vertical Fire Tube Boilers" by F. W. Dean; "The Best Form of Longitudinal Joint for Boilers" by F. W. Dean; "Testing Suction Gas Producers with a Koerting Ejector" by C. M. Garland, A. P. Kratz;; "Bituminous Gas Producers" by J. R. Bibbins. In the evening the members of New York and vicinity gave a reception to the officers and members of the society, their ladies and guests at the Hotel Astor.

Friday.—"The Bucyrus Locomotive Pile Driver" by Walter Ferris; "Line Shaft Efficiency, Mechanical and Economic" by Henry Hess; "Pump Valves and Valve Areas" by A. F. Nagle; "A Report on Cast Iron Test Bars" by A. F. Nagle.

Besides the excursion mentioned there were other excursions of much interest as follows:

International Steam Pump Co., Harrison, N. J., to inspect a modern plant for the manufacture of pump and hydraulic machinery; General Electric Co., Harrison, N. J., to inspect incandescent lamp manufacture; Interborough Rapid Transit Co., W. 58th and 59th Sts. and west side of 11th Ave., to inspect a large central electric light and power station for public service; National Phonograph Co., Orange, N. J., to inspect the manufacture of Edison phonographs and records; De La Vergne Machine Co., E. 138th St., New York, to inspect a new type of oil engine; New York Telephone Co., 61 Irving Place, New York, to inspect the Gramercy and Stuyvesant central telephone exchanges; Crocker-Wheeler Co., Ampere, N. J., to inspect a modern plant for the manufacture of electric generators and motors; Westinghouse Lamp Co., Bloomfield, N. J., to inspect incandescent lamp manufacture; New York Edison Co., E. 38th to E. 40th Sts., New York, to inspect the Waterside electric light and power stations Nos. 1 and 2 for public and private service; Brooklyn Rapid Transit Co., Kent Ave. and Division St., Brooklyn, to inspect a modern central electric power station for public service; Rockland Electric Co., Hillburn, N. J., to inspect gas engines and producers in a modern public service plant; Singer Mfg. Co., 149 Broadway, to inspect the power plant and view the city from the tower 548 feet above the street; Trenton Iron Co., Trenton, N. J., to inspect a modern electric generator plant operated by gas engines; Watson-Stillman Co., Aldene, N. J., to inspect a 300 horse-power Riverside gas engine operating in connection with a Tait producer; Metropolitan Life Insurance Co., E. 23d St. and 4th Ave., to inspect the power plant and view the city from the tower.

The excursion through the Pennsylvania R. R. terminal was of extraordinary interest. The terminal, which is part of one of the world's greatest engineering works, occupies four blocks in the heart of New York, lying between 31st and 33d Sts. and 7th and 9th Aves. It is 784 feet long and 430 wide. Its average height above the street is 69 feet, and maximum height 153 feet. The main waiting room is 277 feet long, 103 feet wide and 150 feet high in the dome. At the track level the station covers an area of 7.74 acres and the total trackage is 16 miles. The number of standing tracks at the station is 21, and the number of passenger platforms is 11. The power house adjacent has a boiler capacity of 5,000 H. P.

The New York terminal extension consists of the Pennsylvania R. R. Tunnel and Terminal Roads forming a connection with the New York division of the Pennsylvania R. R. near Harrison, N. J., which runs over the meadows, under Bergen Hill, North River, Borough of Manhattan and East River through the Sunnyside yards to the Long Island Railroad near Woodside Ave., Queens Borough, Long Island. The total length of the extension is 14.9 miles, including 1.25 mile in the Harrison yard. Of this, 2.78 miles are land tunnels, 2.29 miles river tunnels. The terminal is really a way station on the connecting link between the Pennsylvania R. R. system and the Long Island Railroad system. The terminal building is a beautiful structure lined with Carrara marble and of most impressive proportions.

The large number of interesting excursions and other extraneous features incident to the meeting tended to detract from the value of the technical proceedings. The members generally neglected the sessions, the result being that they were poorly attended and the discussions largely perfunctory. It is a question whether a programme of papers could have been prepared that would have drawn more attendance in view of the manifold outside attractions. If not, it would seem that a change should be instituted in the entertainment and conduct of the meetings if the best interests of the society are to be conserved.

The following officers were elected: George Westinghouse, president; Charles Whiting Baker, W. F. M. Goss, E. D. Meier, vice-presidents; J. Sellers Bancroft, James Hartness, H. G. Reist, managers; William H. Wiley, treasurer.

* * *

Don't use wet or green timbers for countershaft hanging, without tightening up the bolts every week or two, for a while.

PERSONALS

H. L. Pelz is now foreman of the foundry of the Chicago & Alton R. R. at Bloomington, Ill.

L. Fleishfien has been put in charge of the machine department of the Chicago & Alton R. R. shops at Bloomington, Ill.

Fred H. Robinson, with the Bailey Automobile Co., Springfield, Mass., has been promoted to position of foreman of the machine shop.

A. L. Myers, a department foreman of the LeBlond Machine Tool Co., Cincinnati, Ohio, has been made assistant superintendent.

Walter C. English, manager of the Boston office of the *Iron Age* and associated publications, has retired after twenty-six years of service.

C. L. Woodward, mechanical engineer and designer, of the Bailey Automobile Co., Springfield, Mass., has been appointed superintendent of the factory.

The headquarters of Ethan Viall, western editor of MACHINERY, will be 1811 First National Bank Building, Cincinnati, Ohio, after January 15.

J. H. Stevens, who has been in the employ of the LeBlond Machine Tool Co., Cincinnati, Ohio, for some time, has been promoted to the position of machine tool foreman.

C. H. Tucker, recently of the Case Crane Co., is now in charge of the new department of the Toledo-Massillon Bridge Co., devoted to the manufacture of cranes, hoists, coal and ore-handling machinery, etc.

James Healy, for the past three years foreman of the gear-cutting department of the Stevens-Duryea Automobile Co., Chicopee Falls, Mass., has resigned and taken a similar position with the Pierce-Arrow Co., Buffalo, N. Y.

H. A. Isaacs, formerly master mechanic of the Chicago & Alton R. R. at Kansas City, Mo., and later with the Michigan R. R., has been appointed master mechanic of the Chicago & Northwestern Ry., with headquarters at Clarion, Iowa.

Charles Robbins, who for ten years has been employed in the industrial and power sales department of the Westinghouse Electric & Mfg. Co., Pittsburg, Pa., in connection with the sale of industrial motors, was recently appointed manager of this department.

George M. Vial, for the past five years in charge of the wood pattern department of the Stevens-Duryea Automobile Co., Chicopee Falls, Mass., has resigned to take charge of the wood-working department of the public manual training school of Chicopee, Mass.

Clark W. Parker, for the past three years employed by the Lamb Knitting Machine Co., Chicopee Falls, Mass., designing special automatic machinery, has resigned to become president and manager of the Parker Transmission and Appliance Co., Springfield, Mass., which is to manufacture and market one of his inventions.

S. J. Rowe, president of the Rowe Motor Co., Waynesboro, Pa., has been for the past fifteen months designing self-propelled fire apparatus for the American-La France Fire Engine Co., Elmira, N. Y. Mr. Rowe resigned his position with the company, to take effect January 1. He will hereafter devote his entire time to the business of the Rowe Motor Co.

E. P. Haight, well known in electrical circles as the treasurer of the Sprague Electric Co., was elected president of the Electric Trade Association of New York, of which Mr. Franz Neilson, 80 Wall St., is secretary. Mr. Haight's experience in the electrical trade and his energy and enthusiasm doubtless will make his administration of the society unusually successful.

Samuel A. Chase, who for the past few years was a detail and supply salesman in the New York sales office of the Westinghouse Electric & Mfg. Co., Pittsburg, Pa., recently resigned, and has taken a position with the White Investment Co., of New York, a financial investment company handling stock of many organizations. Mr. Chase will be in charge of the Chicago office of the company.

G. Brower Griffin was recently appointed manager of the sales policy of the detail and supplies sales department of the Westinghouse Electric & Mfg. Co., Pittsburg, Pa., in which department transformers, motors, switches and switch-boards, railway line material, etc., are sold. Mr. Griffin was assistant manager of the sales department for six years previous to his promotion to the position of manager, having previously been connected with the sale of detail apparatus in the Boston office.

S. Nicholson was recently appointed general sales manager of the Westinghouse Electric & Mfg. Co., Pittsburg, Pa., and has taken charge of the policy of the entire company. He has been with the company for eleven years in different capacities. He is perhaps best known to electric motor manufacturers as the organizer and president of the American Association of Motor Manufacturers, an organization which has done much in the two short years of its life to improve the art of motor manufacture.
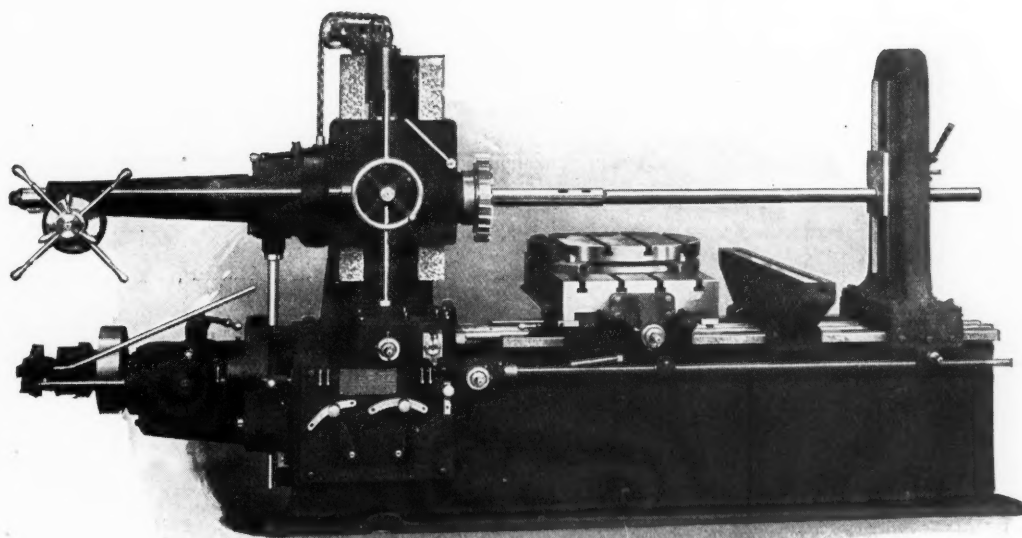
Paul M. Chamberlain has opened an engineering office at 1522 Marquette Building, Chicago, Ill. Mr. Chamberlain was graduated from the Michigan Agricultural College in 1888 and Cornell University in 1890. For several years he was in practical work with the Brown Hoist Co., Cleveland, Ohio; Frick Co., Waynesboro, Pa.; Hercules Iron Works, Aurora, Ill. He then became assistant professor of mechanical engineering at the Michigan Agricultural College, and at the opening of the Lewis Institute at Chicago he took charge of the engineering work and brought it up to its well-known standard of excellence. Mr. Chamberlain has made a special study of boiler-room equipment, economy in fuel burning, and smoke abatement, and will devote his time principally to new designs and improvements in existing installations.

Franklin E. Snow, for twenty-nine years connected with the Wells Brothers Co., of Greenfield, Mass., and for a great part of that time its treasurer, has retired from the active management. F. O. Wells will continue as president and will also act as treasurer. Mr. Snow will be vice-president and Edward Blake, Jr., who has been sales manager for some years, has been elected a director. Mr. Snow has been one of the most prominent factors in the development and prosperity of the Wells Brothers Co., and the growth of the business from a small concern on Mill Street to the present large plant on Sanderson Street has been coincident with his connection. Mr. Snow is also interested as a stockholder in a number of other Greenfield manufacturing enterprises, to the success of which his business ability has contributed in a marked degree. In the enjoyment of a well-earned rest he will doubtless still find time to perform, in his quiet and genial way, the various duties which fall to the lot of the public spirited citizen.

Charles H. Kirchhoff, for twenty years editor-in-chief of the *Iron Age*, retired December 1. Mr. Kirchhoff graduated from the Royal School of Mines, Clausthal, Germany, and before entering journalism in 1877 he was a mining engineer and metallurgist. He worked as a chemist for the Delaware Lead Refining Co., Philadelphia, Pa., from 1874 to 1877, and during that time began contributing to the *Metallurgical Review*, and later became its assistant editor, remaining on its staff two years. Leaving the *Metallurgical Review*, he joined the staff of the *Iron Age* as assistant editor, and after two years service became editor of the *Engineering and Mining Journal*. In 1884 he returned to the *Iron Age* as associate editor, and in 1889 became its editor-in-chief. Mr. Kirchhoff is generally regarded as an authority on metallurgy and steel manufacture. He has a wide acquaintance among the steel manufacturers, and his personality undoubtedly has been a potent factor in the success and prestige of the journal that he conducted so long.

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OBITUARIES

Joseph Campbell, president of the Diamond Saw and Stamping Works, Buffalo, N. Y., died November 29.

John B. Chapman, senior member of J. B. Chapman & Co., brass founders, coppersmiths, and machinists, Springfield, Mass., died at his home in that city December 6, aged fifty-five years.

F. L. Gallagher secretary and treasurer of the Modern Tool Co., Erie, Pa., died suddenly November 29, aged forty-one years. Mr. Gallagher was formerly with the Metric Metal Works, with which concern he was employed as bookkeeper until about nine years ago, when he became manager and treasurer of the Modern Tool Co. He was a man of much popularity.

Alden Sampson, 2nd, proprietor of the Alden Sampson Mfg. Co., maker of automobile and automobile trucks, Pittsfield, Mass., died at his home, December 3, aged thirty-one years. Mr. Sampson contracted a cold which developed into double pneumonia while on his homeward trip from France in the middle of November, where he had gone to observe the use of automobile trucks in army manœuvres.

Dr. Charles B. Dudley, the well-known chemist in charge of the Pennsylvania R. R. Co.'s testing work, died at Altoona, Pa., December 21, of typhoid-pneumonia, aged sixty-seven years. He held the position with the Pennsylvania R. R. Co. since his graduation from the Sheffield Scientific School in 1874. He was twice president of the American Chemical Association, and was a vice-president of the American Institute of Mining Engineers. He was also president of the American Society for Testing Materials for several years.

William Metcalf, a pioneer steel manufacturer and one of the best known metallurgists in the United States, died at his home in Pittsburg, Pa., December 7, aged seventy-one years. During the Civil War Mr. Metcalf was in charge of the Fort Pitt foundry, Pittsburg, where much of the heavy artillery used by the Northern armies was made. It was in this foundry that the Rodman cannon were cast, the Rodman process being the first effort of importance to make cannon with the internal layers in a state of compression due to cooling the core rapidly. Mr. Metcalf was head of the Braeburn Steel Co., which he organized in 1897. He was the author of several books on steel and metallurgy; his book on tool steel was for many years the only authoritative American work on the subject. In 1880 he was elected president of the American Institute of Mining Engineers, and president of the American Society of Civil Engineers in 1893. He was also vice-president of the American Society of Mechanical Engineers in 1882-1884.

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COMING EVENTS

January 1-8.—Tenth international exhibit of automobiles and automobile appliances, Grand Central Palace, New York, under the auspices of the American Motor Car Manufacturing Association. R. E. Olds, chairman, 505 Fifth Ave., New York.

January 8-15.—Association of Licensed Automobile Manufacturers' tenth annual exhibition of automobiles and automobile appliances, Madison Square Garden, New York. M. L. Downs, secretary, 7 East 42d St., New York.

January 18-20.—Annual meeting of the American Society of Heating and Ventilating Engineers. W. M. Mackay, secretary, P. O. Box 1818, New York.

January 19-20.—Annual meeting of American Society of Civil Engineers, New York. Charles W. Hunt, secretary, 220 West 57th St., New York.

May 31-June 3.—Spring meeting of the American Society of Mechanical Engineers, Atlantic City, N. J.

June 7-9.—Convention of the American Foundrymen's Association and American Brass Founders' Association, Detroit, Mich. Headquarters, Hotel Ponchartrain. Richard Moldenke, secretary, American Foundrymen's Association, Watchung, N. J. W. M. Corse, secretary, American Brass Founders' Association.

June 1-August 31, 1910.—American Exposition in Berlin, under illustrious auspices, to stimulate trade relations between Germany and America. This will be the first all-American exposition ever held in a foreign country and will be of interest to all Europe as well as America. It will be held during three of the best months of the year for an exposition, being at the full tide of the foreign travel when people will be attracted in large numbers. Max Vieweger, American Manager, 50 Church St., New York.

July 26-29.—Joint meeting of the American Society of Mechanical Engineers and the British Institute of Mechanical Engineers in England.

SOCIETIES AND COLLEGES

IRON & STEEL INSTITUTE, G. C. Lloyd, secretary, London, England, announces that Mr. Andrew Carnegie, past president of the association, has presented the institute with $100,000 for research scholarships. The object of this scheme of scholarships is to enable students who have passed through college or who have been trained in industrial establishments to conduct research experiments in iron and steel and related subjects. The appointment for scholarship is for one year, but the council may at its discretion renew the scholarship for a further period. Further information may be obtained from the secretary.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Boston, Mass., during the past year has made the requirements for the degree of Doctor of Engineering more definite, and has placed it in the hands of the board which also administers the regulations for the degree of Doctor of Philosophy. The requirements for the degree of Doctor of Engineering and Doctor of Philosophy have now been made substantially equivalent. The executive committee has voted two Austin research scholarships carrying a sum of $500 each and remission of tuition fees. These are now open to candidates for degrees of Doctor of Engineering and Doctor of Philosophy.

MUSEUM OF SAFETY AND SANITATION, 29 West 39th St., New York, through its secretary, Dr. William H. Tolman, is giving stereopticon lectures on safety devices. A description of the work of the safety committee of the United States Steel Corporation made in Rochester so impressed the superintendent of the Rochester Railway and Lighting Co. that he organized a committee of safety in his company which employs 2,500 people. The practical results of Dr. Tolman's work are made clear by events like this which promote methods, rules and regulations for the preservation of life and limb in industrial works, railroads and other activities of life.

UNIVERSITY OF ILLINOIS, Urbana, Ill., has recently issued a circular descriptive of its course in mining engineering lately established. The bill establishing the department of mining engineering in the state university was passed by the last state legislature. The mining and metallurgical products of the state of Illinois, for 1907, represent an output value of over $150,000,000. Although Illinois is generally regarded as an agricultural state, it has for many years occupied second place among coal producing states and the rapid development of the iron industry about Chicago has already placed the state well up among the iron and steel producing states.

CATALOGUES AND CIRCULARS

ROBBINS MACHINE CO., Worcester, Mass. Circular of Robbins 14-inch engine lathe with compound and elevating rest.

BOICOURT CO., Fort Worth, Texas. Circular of Boicourt steam power pumps, deep well pumps and deep well working head.

B. C. AMES CO., Waltham, Mass. Catalogue of bench lathes and fixtures, bench milling machines and dial gages. The company builds small machinery to order.

S. A. WOODS MACHINE CO., Boston, Mass. Circular of inside molders, a new wood-working tool in which the advantages of a molder, shaper and matcher are comprised in one machine.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Boston, Mass. Catalogue of the Institute giving roster of officers and instructors, courses of study, roll of students and graduates, etc.

CHICAGO PNEUMATIC TOOL CO., Chicago, Ill., and New York. Circular descriptive of Franklin tandem gasoline engine driven air compressors adapted for isolated compressed power units.

NORTHERN ENGINEERING WORKS, Detroit, Mich. Booklet 24-B of Northern electric traveling cranes, hand power cranes, jib cranes, overhead trolleys, electric hoists, steel derricks, etc.

GENERAL ELECTRIC CO., Schenectady, New York. Bulletin No. 4708 on Thompson direct current test meter type CB-3, designed as part of the equipment of central power stations for periodical meter testing.
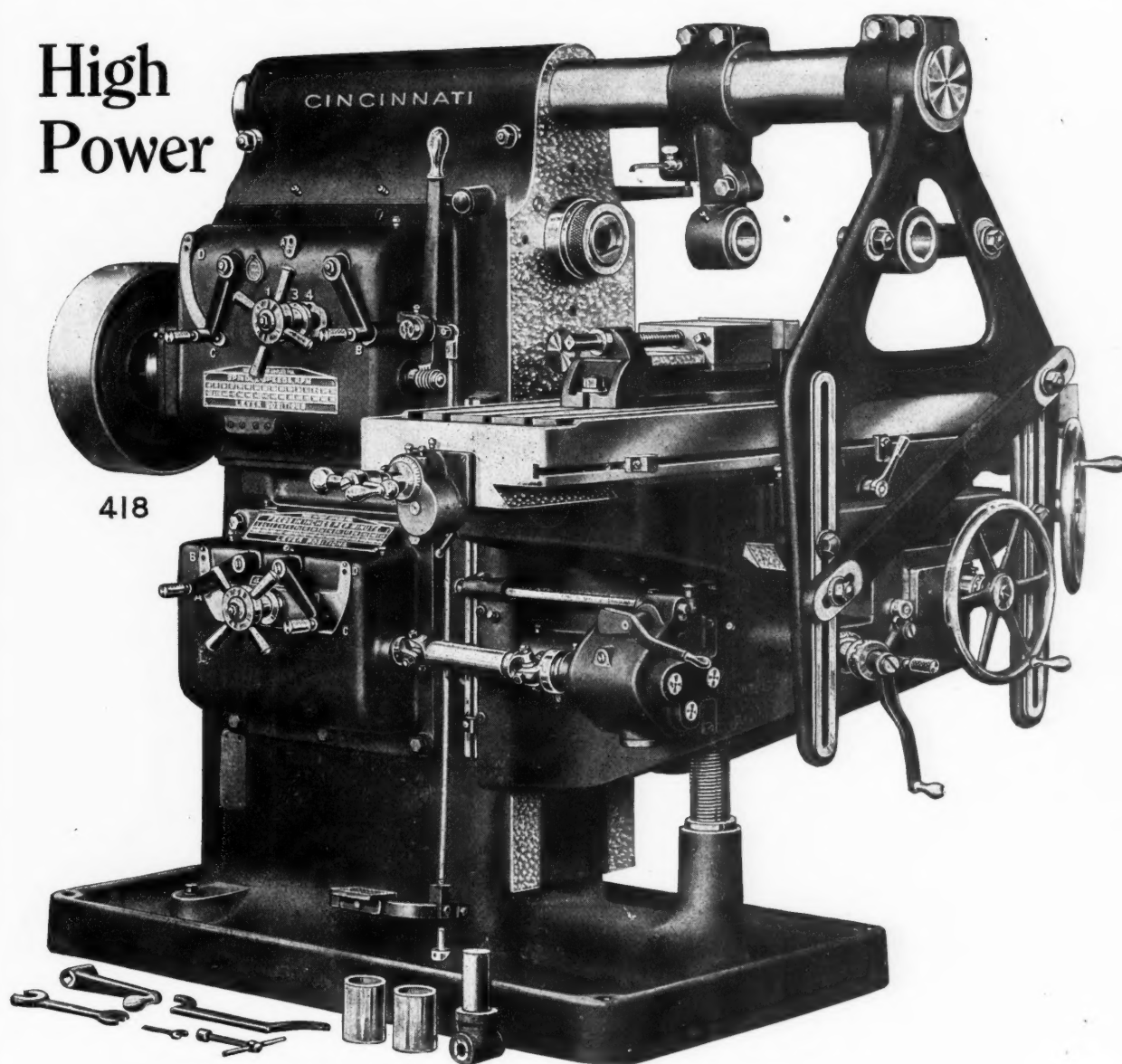
M. RUMELY CO., La Porte, Ind. Pamphlet entitled "Toiling and Tilling the Soil," beautifully illustrated, advertising the Rumely "Oil Pull" tractor, a gasoline traction engine designed for plowing and hauling on farms.

GISHOLT MACHINE CO., Madison, Wis. Leaf illustrating and describing Gisholt lathe equipment for finishing valve bodies and work of a similar nature. Also leaf illustrating Gisholt lathes used in automobile shops.

MESTA MACHINE CO., Pittsburg, Pa. Circular of Corliss-engine driven compressors for large capacities and pressures up to 1,000 pounds per square inch, and hoisting engines for heavy duty service and large capacities.

CONTENTS FOR JANUARY

AMERICAN BLOWER CO., Detroit, Mich. Copy of recent decision of Judge Hough of the United States Circuit Court sustaining its suit against the B. F. Sturtevant Co., Boston, Mass., for infringement of patent covering Sirocco fans and blowers.

CROCKER-WHEELER CO., Ampere, N. J. Bulletin No. 116 on motor generator sets for air pumps; bulletin No. 117, "Motor Drive in the Laundry;" and bulletin No. 118 on form L direct current motors 1/20 to 7½ H. P. and generators 0.6 to 3½ K. W.

ARGUTO OILLESS BEARING CO., Waynesboro, Pa. Folder advertising Arguto oilless bearings for lineshafts and countershafts in cotton mills and other locations where it is desirable to avoid the use of oil because of danger of contaminating the product.

WESTINGHOUSE ELECTRIC & MFG. CO., Pittsburg, Pa. Circular No. 1506 entitled "Recent Types of Arc Lamps and their Operation," by C. E. Stevens. The paper briefly discusses arc lamps in general, and describes the metallic flame arc lamp and its mechanism.

E. G. SMITH, Columbia, Pa. Catalogue of Columbia calipers, "which-way" pocket level, Columbia spherometer, steel rules, etc. The Columbia caliper is made in various styles, one of which is provided with a vernier that makes the reading of 64ths or 128ths as easy as 16ths with the ordinary plain graduation.

AMERICAN OXYHYDRIC CO., Milwaukee, Wis. Pamphlet on the oxyhydric process for cutting and welding metals. The apparatus and interesting examples of work done are illustrated, including clearing away the tangled steel debris resulting from a boiler explosion in the Pabst brewery, cutting 9-inch nickel-chrome armor plate, etc.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4705 on the Curtiss steam turbines for low pressure and mixed pressure. Various installations are illustrated, including a 5,000 K. W. low pressure Curtiss turbine generator at the 59th St. station of the Interborough Rapid Transit Co., New York.

GOULD & EBERHARDT, Newark, N. J. Folder entitled "The Building of a Reputation," giving a brief history of the concern and advertising the Eberhardt automatic gear-cutting machine for spur and bevel gears, automatic generating machinery for hobbing spur, worm and spiral gears, rack cutters and shapers.

COLBURN MACHINE TOOL CO., Franklin, Pa. Circular describing the Colburn floating reamer holder for use in boring mills with turret heads. (See MACHINERY, December, 1909.) These holders are made in two sizes, No. 1 having a No. 4 Morse taper socket and No. 2 a No. 5 socket, the maximum capacity being holes 3 and 4 inches diameter respectively.

ROCKWELL FURNACE CO., New York. Bulletin G on annealing, hardening, and tempering furnaces fired with oil or gas fuel. These furnaces are adapted for treating, hardening, tempering, case-hardening, and annealing tools, dies, taps, punches, cutters, screws, springs; nickel, chrome, vanadium, high-speed and carbon steel; brass, copper, silver, aluminum, etc.

GENERAL ELECTRIC CO., Schenectady, N. Y., has issued an attractive pamphlet, "The Dawn of a New Era in Lighting," which treats of the history of lighting from the tallow dip to the latest development in artificial lighting, i. e., the tungsten lamp. The pamphlet describes the tungsten lamp and gives figures on its efficiency, cost of operation, and describes various applications of the lamp in interior lighting. The pamphlet is No. 3885 in the series of advertising material published by the company.

SCHUCHARDT & SCHUTTE, 90 West St., New York. Catalogue of automatic gear hobbing machines, hob grinding machines, hob milling machinery, profile milling machines and profile grinding machines. The catalogue will be found of general interest by gear makers. It contains an illustration of the Schuchardt & Schutte factory interiors, showing the erection of hobbing machines; also views of the Melville-Macalpine spiral reducing gear built for transmitting 6,000 horsepower from steam turbines to marine propellers.

BRISTOL CO., Waterbury, Conn. Bulletin No. 114, illustrating and describing Bristol's recording gages for pressure and vacuum; also Bristol's recording water level gages. The practice of recording data of pressures, vacuum, water level, etc., in power plants and other places is becoming more and more prevalent as the advantages of such records are recognized. The Bristol Co. has had twenty years' practical experience in the development and manufacture of recording instruments, and offers its experience to all interested in recording such data.

JOSEPH T. RYERSON & SON, Chicago, Ill. Ryerson Reference Book for 1910, being a complete list of the most comprehensive stock of iron, steel, machinery, and allied specialties in the world, to which are added useful tables and information for engineers, architects, contractors, structural iron workers, etc. The reference book contains 380 pages with index, and lists beams, angles, channels, T's, Z-bars, steel separators, flanges, and tank steel parts and other steel and iron specialties, boilermakers' machinery, including the Ryerson line of internal combustion machinery (see MACHINERY, July, 1909). The tables and other data will be found generally valuable by users of structural shapes, plates, etc.

CINCINNATI MILLING MACHINE CO., Cincinnati, Ohio. Catalogue of horizontal milling machines (cone and single-pulley types), vertical milling machines, accessories, attachments, etc. The catalogue contains 160 pages filled with illustrated and descriptive matter. Some important improvements on the Cincinnati Nos. 1, 1½, 2 and 3 cone-driven machines are shown, especially in the column and feed mechanism. The column now used is similar to that used on the Cincinnati high-power machines, being a complete box form, containing the entire feed mechanism. The catalogue also illustrates the Cincinnati universal cutter and tool grinder which is a necessary accessory of milling machine equipment. Mechanics will find it of interest and value, if for no other reason than because of the detail illustrations throughout, and, the directions contained in the chapter "Erection and Care of Millers." A full index adds to the value by making reference to descriptions of machines, accessories, etc., easy, and obviates the necessity of thumbing over the pages until the desired matter is found.

NILES-BEMENT-POND CO., 111 Broadway, New York. Pamphlet entitled "Grinding—Not Milling—the Way to Machine Flat Surfaces," being an illustrated description of the Pratt & Whitney vertical surface grinder and some products. It is claimed that the Pratt & Whitney surface grinder with vertical spindle will grind from twelve to twenty times faster than ordinary surface grinders. The efficiency of the machine is partly due to the cup-shaped wheel, which covers the full width of the work while it reduces it to perfect flatness. The horizontal table facilitates chucking all ordinary work, and the magnetic chuck makes the chucking of small work very simple and rapid. Illustrations of work done comprise flat-irons aluminum castings, carbon segments, cast-iron flanges, circular saws, repeating rifle hammers and ejector levers, automatic pistol frames, knife blades, hardened steel planer knives, carpenters' planes, aluminum and iron automobile manifolds, automobile steering gear housings, automobile transmission gear cases, gear blanks, automobile cam shafts, typewriter parts, lathe chuck bodies, cast iron frames, etc. The pamphlet is a fine example of typographical work and will be found very interesting by all concerned in the economical and rapid production of surface ground work, whether they be shop managers, superintendents, foremen or machinists.

TRADE NOTES

WHITE CO., Philadelphia, Pa., is putting a gasoline-motor driven truck of 1½ ton nominal capacity on the market.

CHICAGO BELTING CO., Chicago, Ill., has opened a branch store at 71 Dey St., New York, with Mr. E. T. Toogood manager.

HUTHER BROS. SAW MANUFACTURING CO., Inc., Rochester, N. Y., announces that it also manufactures sheet steel specialties.

EXPORT CORPORATION, LTD., 29 Broadway, New York, wants estimates and plans of a complete plant for refining and briquetting salt.

RAE ELECTRIC VEHICLE CO., Springfield, Vt., is a new enterprise which will be ready for business in January. It is erecting a new factory.

THE SUPERIOR TAP CO., Springfield, Vt., has been reorganized, and will move to Charlestown, N. H., where a factory is being constructed for its use.

BAILEY AUTOMOBILE CO., Springfield, Mass., is making important changes in its factory and will bring out a new two-cycle motor for its 1910 cars. New machinery will be installed.

SPITZLE MFG. CO., Utica, N. Y., was recently made the sales agent of the Fulton Machine & Vise Co., Lowville, N. Y. The company will market the entire product of the Fulton Machine & Vise Co.

STANDARD WELDING CO., Cleveland, Ohio, has recently added to its large factory a two-story building giving 50,000 square feet additional space which will be utilized by the tube welding department.

WELLS BROS. CO., Greenfield, Mass., held its annual meeting of stockholders December 1 and elected the following officers: Frank O. Wells, president and treasurer; F. E. Snow, vice-president, and Messrs. Wells, Snow, White, Blake and Pratt, directors.

AIR BRAKE MAGAZINE, Meadville, Pa., is a new journal published by the Air Brake Magazine Co., and edited by Frank H. Dukesmith. As the name indicates, the journal is devoted to the principles, construction, action and use of steam and electric railway air brakes.

Q. M. S. CO. (Quincy-Manchester-Sargent Co.), Plainfield, N. J., has moved its Western office in Chicago from 1775 Old Colony Building to 738 First National Bank Building. The company's interests in the West will hereafter be taken care of by Mr. J. C. Hoof.

TOLEDO-MASSILLON BRIDGE CO., Toledo, Ohio, has recently added a new department to its business, having gone into the extensive manufacture of all kinds of cranes, hoists, coal and ore-handling machinery, etc. C. H. Tucker, recently of the Case Crane Co., is in charge of the new department.